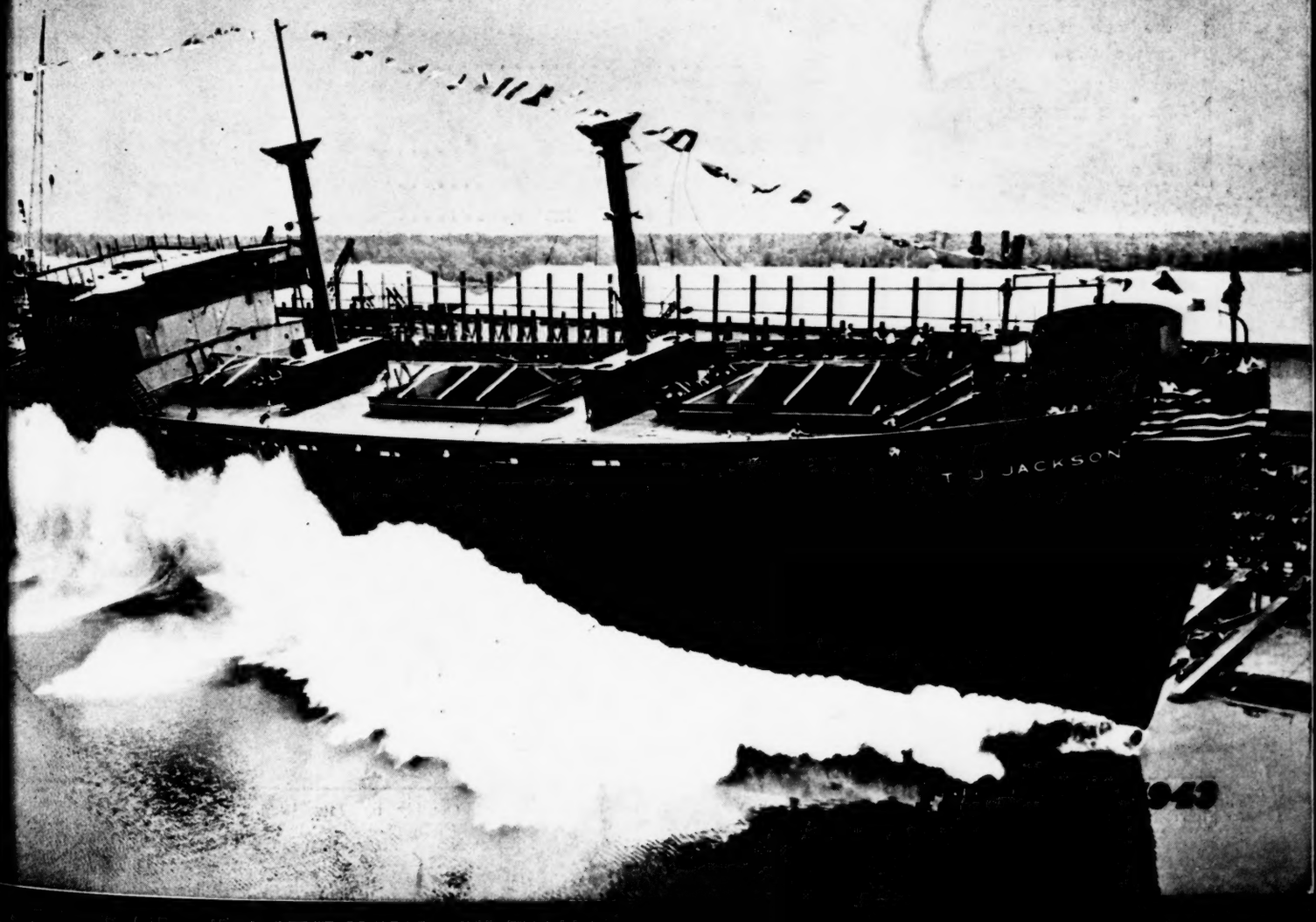
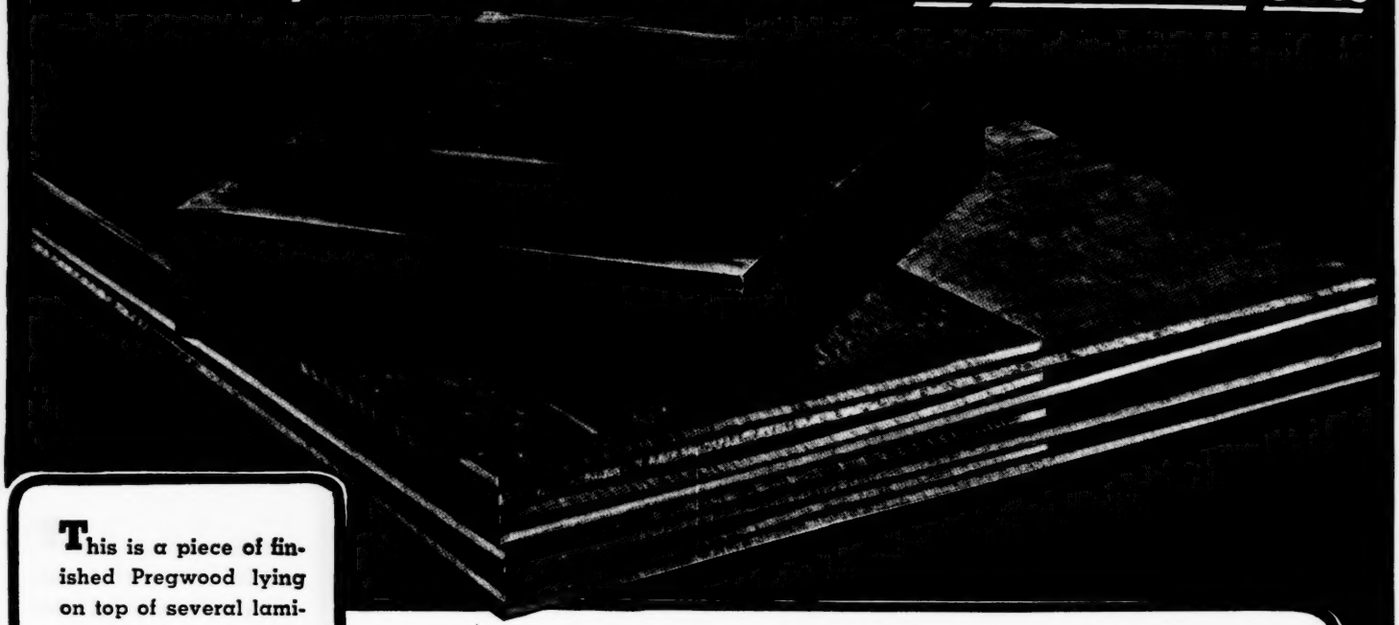
HEATING AND VENTILATING

THE AIR CONDITIONING MONTHLY



"PREGWOOD" FORMICA

A LIGHT, STRONG MATERIAL for Mechanical Uses



This is a piece of finished Pregwood lying on top of several laminations of impregnated but uncured wood arranged to produce "Crossed Grain" Pregwood. The natural wood is reduced to one-half its original thickness when processed. In parallel grain Pregwood the laminations all run in the same direction.

PHYSICAL PROPERTIES OF PREGWOOD	CROSSED GRAIN	PARALLEL GRAIN
Specific Gravity	1.34	1.34
Tensile Strength PSI	12,000	30,000
Compressive Strength PSI	15,000	20,000
Modulus of Rupture in Bending PSI	18,000	35,000
Modulus of Elasticity in Bending PSI	2.0×10^6	2.7×10^6
Izod Impact	4 ft. lbs. per inch of notch	5 ft. lbs. per inch of notch
Shear perpendicular to laminations PSI	5,000	5,000
Shear Parallel to laminations PSI	4,000	
Moisture Absorption Maximum	6 per cent in 24 hours	6 per cent in 24 hours

Pregwood is a composite of wood veneers, thoroughly impregnated with thermosetting resin, compressed to half its original bulk, and cured into a hard, strong homogenious material.

It has great strength, stability of dimensions, and light weight—qualities much appreciated by the aviation as well as many other industries. The material is produced in sheets of varying thicknesses. It can be machined readily to dimensions with the same tools that are used for cast iron.

Pregwood can be successfully glued to wood. It is offered for propeller hubs, complete propeller blades, and for edge strips glued to wood in air frame construction so that the bolts and fastenings attached through the "Pregwood" will not work loose. Samples on request.

THE FORMICA INSULATION CO., 4666 SPRING GROVE AVE., CINCINNATI, O.

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for . . .

engineers and contractors controlling the design, specification, installation and maintenance of heating, ventilating and air conditioning.

HEATING AND VENTILATING

The Air Conditioning Monthly

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CONTENTS FOR FEBRUARY, 1943

VOLUME 40 NUMBER 2

Ships for Victory	29
Ventilation and Heating of Maritime Commission Ships	32
Air Conditioning for Refrigeration Life Tests	58
Marine Propulsion Gears	60
Reference Section 9—Wartime Design Restrictions for Conservation	60-A
Relationship of Disease and Weather	61
Degree Days for December, 1942	67
Washington News	69
Sizing Small Pipe Columns	72
News of the Month	74
Reference Data 239 and 240	76
Reviews of Technical Publications	78
What Readers Say	80
New Equipment	82
New Catalogs	84
With the Manufacturers	85
Personals and Personnel	86
Industrial Degree Days for December	87
Coming Events	87
H&V Photos	87

THIS ISSUE · ONE DOLLAR

On THIS MONTH'S COVER of HEATING AND VENTILATING appears our new masthead. The photograph used is by courtesy of the U. S. Maritime Commission

MEMBER
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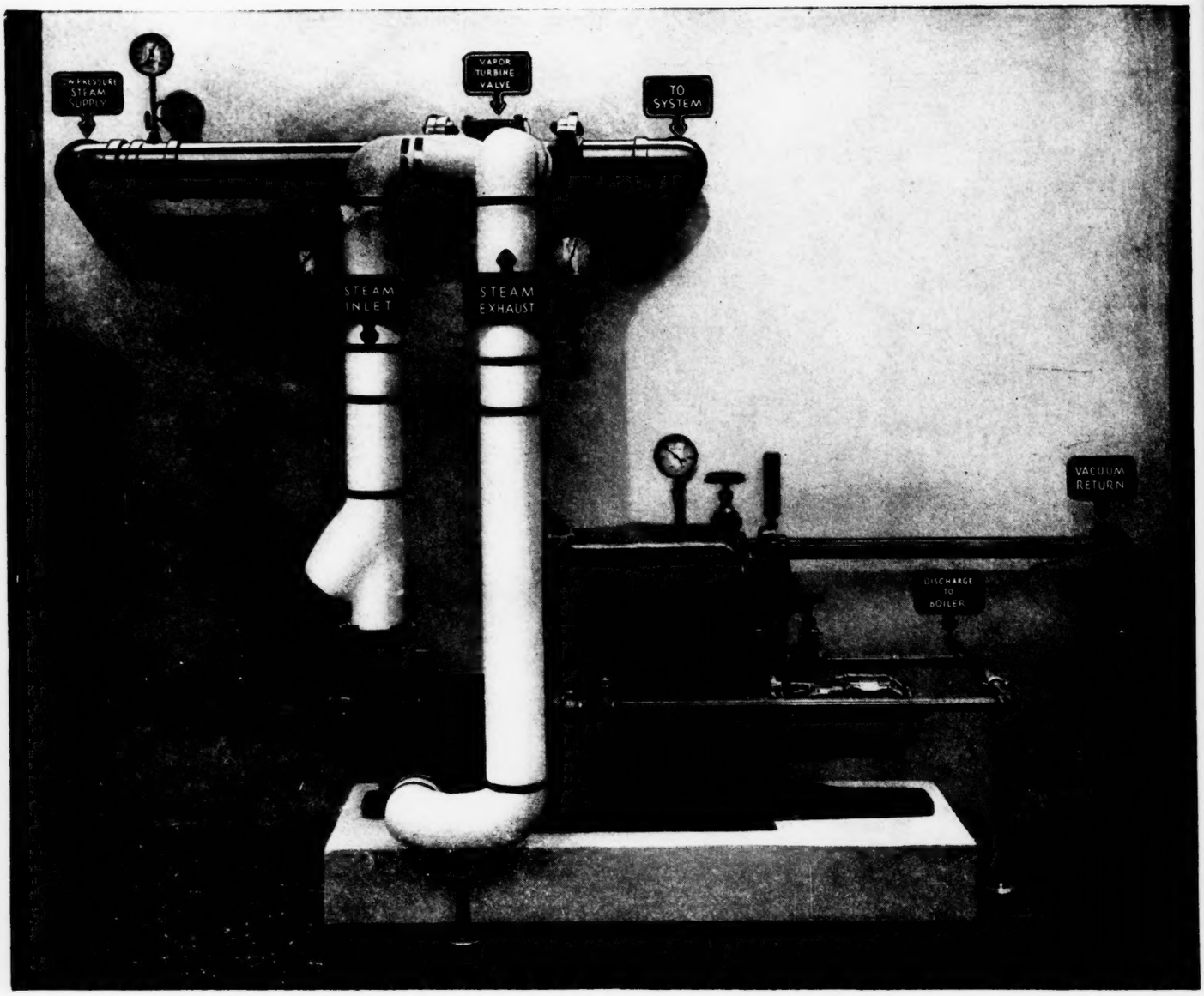
Interrupted Electric Service will not stop this NASH Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

THE NASH ENGINEERING COMPANY

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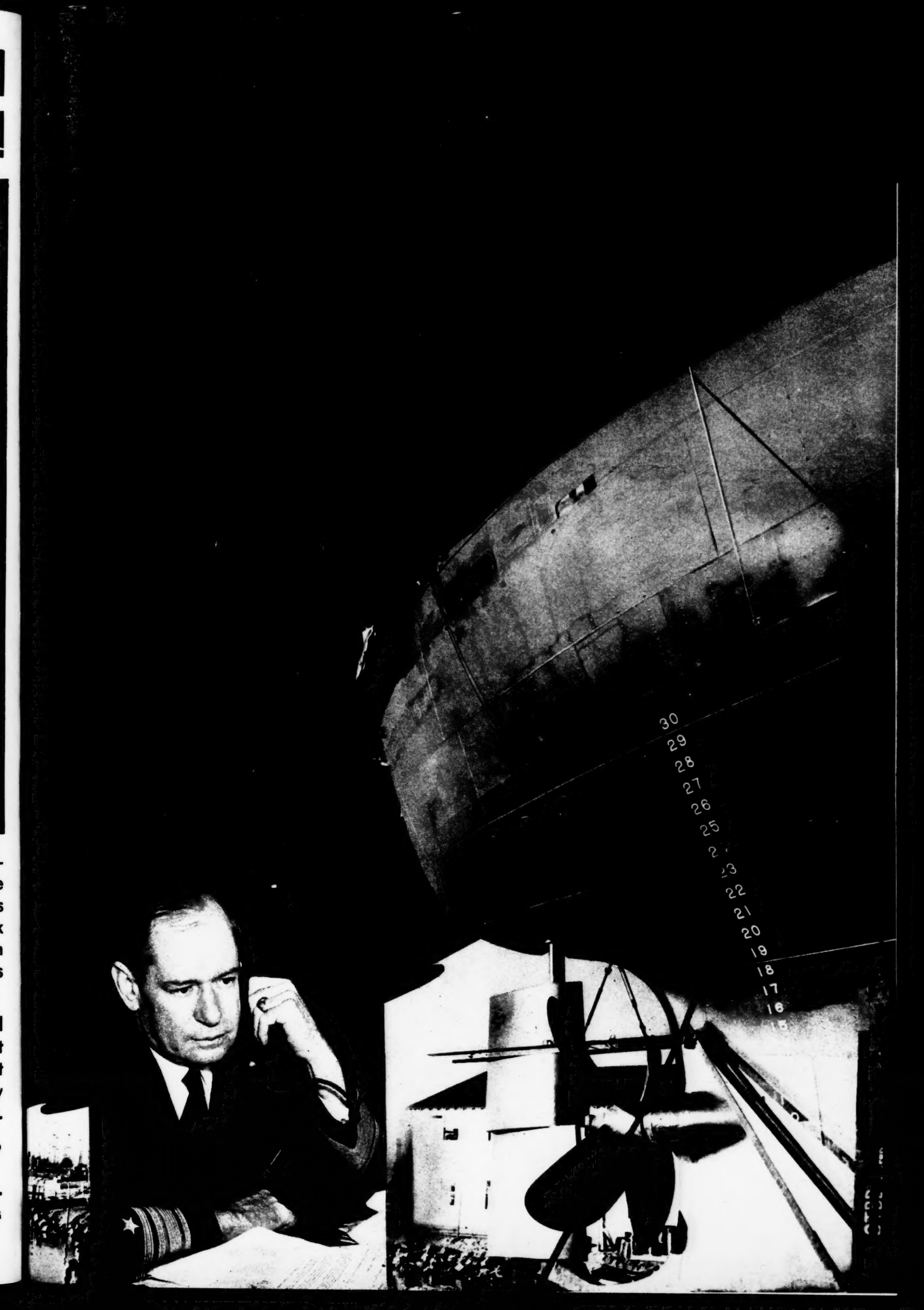
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22
21
20
19
18
17
16

THE heavy reliance placed upon the merchant marine to supply and support the armed forces will certainly increase this year as the United Nations intensify their attacks upon the Axis powers. With the offensive shifting to the control of the United States and our Allies, more and more cargo ships will be needed to transport guns, oil, food, and other materials of war to battlefronts all over the world.

American shipbuilders, in order to meet these unprecedented wartime demands, have accomplished one of the most prodigious tasks in the history of industry. Shipbuilding—for so long a neglected craft in America—has grown into a vast enterprise that produced more than 8,000,000 deadweight tons of merchant vessels in 1942 and reached the record-breaking rate of four ships a day in December. In that month 121 oceangoing vessels totaling about 1,200,000 deadweight tons were placed in service.

The U. S. Maritime Commission's program calls for at least 16,000,000 deadweight tons in 1943. By May, when the last of the emergency shipyards authorized by the Commission go into production, we shall reach the rate of five ships a day, or approximately 1,500,000 deadweight tons a month.

On sandy beaches or coastal marshland a score of new shipyards have been built virtually overnight. Old yards have been enlarged and improved so that now more than 60 shipyards with approximately 300 ways are building dry cargo ships and tankers.

Before these facilities could be made productive, thousands of new, inexperienced workers had to be trained. More than a half million men and women are now building craft for the merchant marine, and approximately a million more workers are employed in factories all over the country producing equipment and accessories for ships.

This army of production soldiers—90% of them newly recruited—built 746 large, oceangoing cargo vessels in 1942. In addition, a number of vessels were built for the armed services and 800 small craft such as tugs and barges also were produced.

A total of 542 Liberty Ships, comprising about 70% of last year's construction, was delivered. These vessels have proved themselves eminently successful both from the standpoint of speedy construction and efficiency of operation. The drastic shortage of shipping at the outbreak of hostilities necessitated the adoption of a standardized vessel which could be produced in large numbers and placed in war service with the least possible delay.

The speed with which these 10,500-ton freighters are being turned out far outstrips the shipbuilding effort of the last war when very few vessels were completed in time for war zone operation. The peak of production was not reached until almost a year after the armistice.

Many of the half thousand Liberty Ships now at sea carrying the sinews of war to distant battlefronts have already been under enemy fire. They have traveled the tortuous North Atlantic route to Murmansk, a voyage beset with U-boats, surface raiders and aircraft. They have carried supplies across the Pacific, and they formed part of the great convoy which landed the American invasion force in North Africa. Not one of these vessels was in service at

the time of the attack on Pearl Harbor but hundreds are now an integral part of our military operations which bind America closer to her Allies and link the industrial worker to the man on the firing line.

The average building time for Liberty Ships has "crash-dived" since the first went into production. The three vessels completed last January required about 240 days from keel-laying to delivery. In December 82 Liberty Ships were placed in service in an average building time of only 55 days.

Only two shipyards were in production in December 1941. Each delivered one Liberty Ship. At the close of 1942 there were 13 yards turning out Liberties at the rate of almost three a day. Four more yards with six ways each, to be used exclusively for Liberty Ships, are nearing completion. With these additions, the emergency cargo ship program will encompass 17 yards aggregating approximately 140 shipways.

Construction of other type vessels for the Maritime Commission has also been accelerated. Last year 62 high-speed tankers were delivered, compared with only 28 built in 1941. Production reached a new monthly high in December when 10 tankers were delivered and an even higher rate is expected during 1943.

Five shipyards on the Atlantic Coast are now building these vitally needed oil carriers. Another recently went into production in Oregon, the first yard to build large type tankers on the West Coast.

Under its original program to restore the American Merchant Marine, the Maritime Commission designed fast, economical freighters known as the C-types and planned to build 50 a year for a decade. These vessels, which are being built under the war program, incorporate every modern feature for speed and safety. As the nucleus of a new merchant fleet, they will place the United States in a favorable position to compete for a just share of the world's oceanborne commerce.

The war naturally dominates every aspect of our Nation's industrial and economic life. The peacetime maritime program therefore has been temporarily overshadowed by the assembly line production of Liberty Ships. But even under the stress of wartime conditions the 50-a-year rate was exceeded by 25% in 1942 with the delivery of 62 C-type vessels.

Four of the Atlantic Coast yards building tankers are devoting part of their facilities to the construction of C-types, and two other yards in the East are working on them exclusively. In addition, four yards on the Pacific Coast and three on the Gulf are building C-types.

American flag vessels are circling the globe in growing numbers, setting their course towards every theater of war. Almost every day they dock at some foreign port or drop anchor off a small Pacific island to deliver the armaments that will speed the onward march of our fighting men.

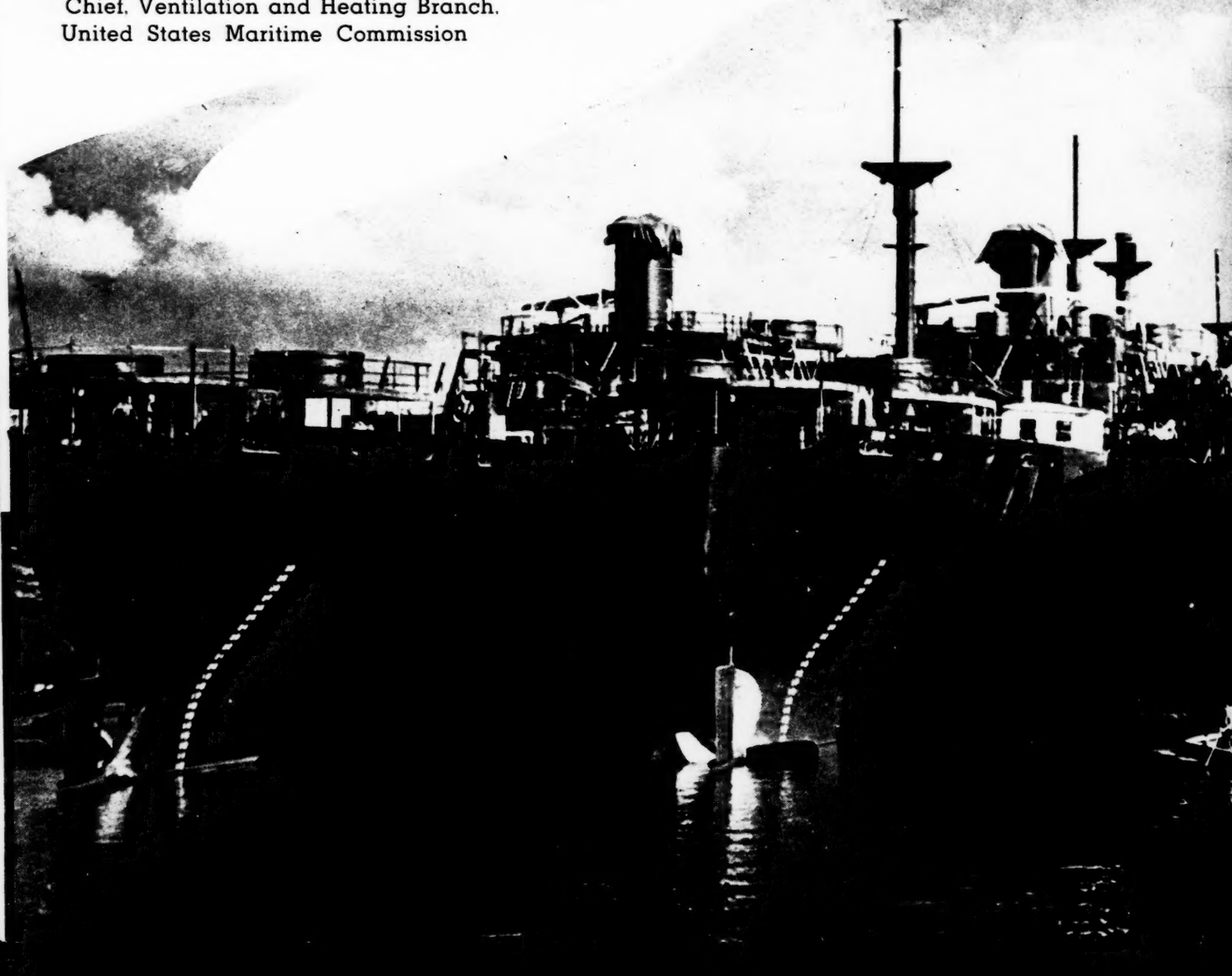
The record accomplishments of American shipbuilders last year were only a prelude. Beyond the delivery of 8,000,000 deadweight tons of merchant ships in 1942 was the creation of a great new shipbuilding industry that can and will double its production this year.

# of Maritime Commission

Ships

By JOHN W. MARKERT

Chief, Ventilation and Heating Branch,
United States Maritime Commission



THE ventilation and heating of merchant ships have made considerable advances in this country within the last decade. Broadly speaking, mechanical ventilation, automatic hot blast, and convector heating have supplanted natural ventilation and cast iron radiators so common on older ships. This progress may be attributed to several causes, including:

(1) Developments in ventilation and air conditioning ashore;
(2) General improvement in living conditions for operating personnel;
(3) Close competition in passenger trade; and
(4) War conditions which eliminate many common means for natural ventilation, and which present special problems.

It must be admitted that in many cases marine standards and practice have not kept abreast of the advancements made on land. This has been due principally to slack periods during which few ships were built. Every effort is now being made to remedy this, but under present circumstances ad-

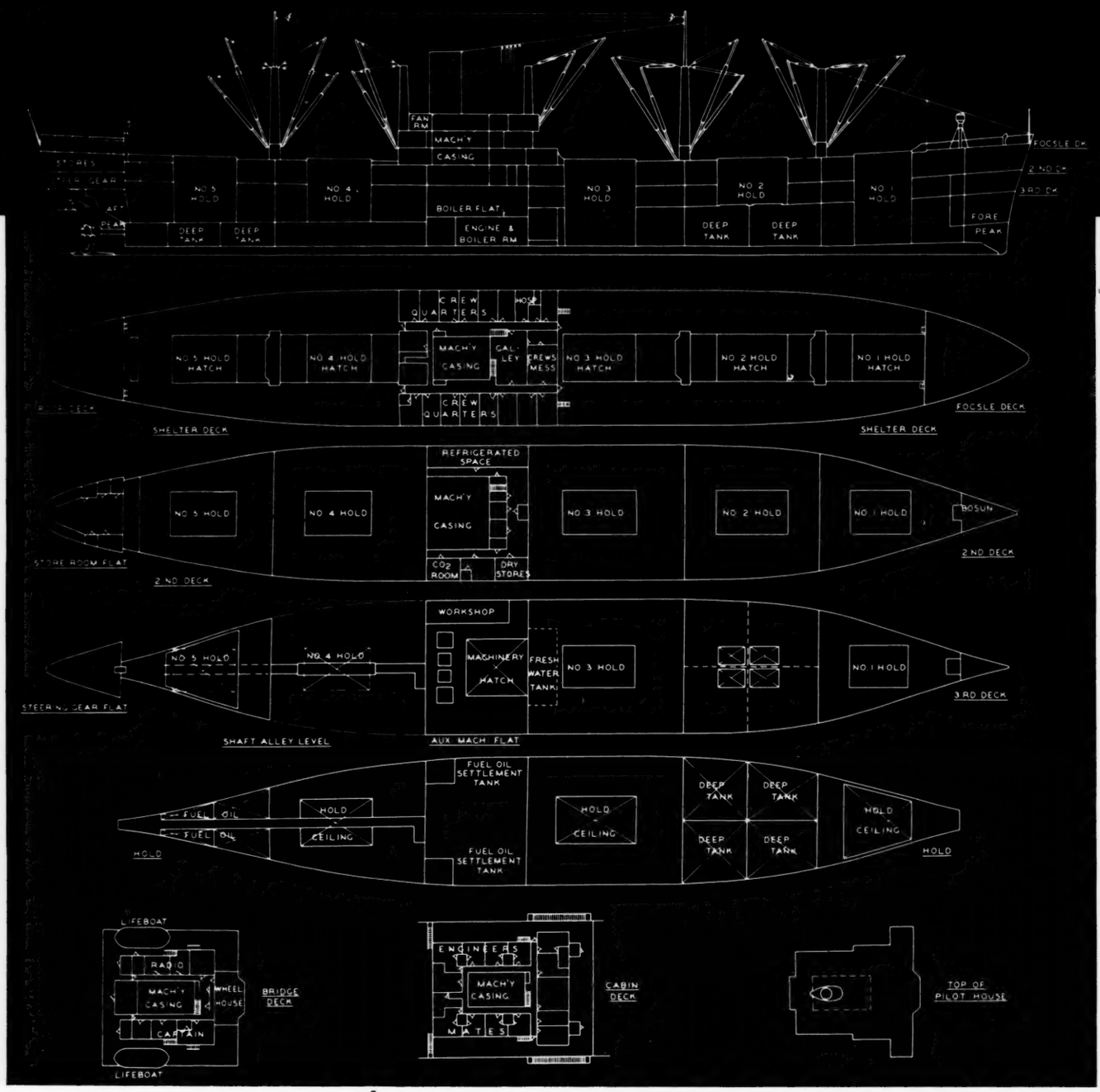


Fig. 1. Arrangement plans and profile of typical cargo vessel.

vancement is limited by military considerations. The design of luxury liners for post-war trade is being considered, but the immediate problem is shipment of troops, materials, and other operations essential to the war. No comfort air conditioning is provided today.

Legislation and other requirements (both governmental and private) have materially improved the living quarters of operating personnel. Strange as it may seem, most foreign and domestic laws and regulations apply only to the operating personnel (unlicensed in particular) and steerage passengers. It is assumed that competition dictates the degree of comfort provided for other passengers.

The disadvantages of blackouts are no novelty in ship operation. Even in peace time certain portions of vessels must be darkened to assist navigation. Under the present conditions all vessels must be blacked out when at sea. Air ports in the main hull structure have been eliminated or "plated in." Use of wind scoops for ventilation purposes has been materially reduced. Even when air ports are available, they must be fitted with a light excluding device which greatly reduces the effectiveness of this form of natural ventilation.

Not only has the volume of ventilation equipment on the average ship increased, but also the number of ships required to satisfy present day demands. The rate of ship production is increasing each month, and the sudden growth of this demand has naturally caused a great shortage of qualified personnel (both operating and design), suitable equipment, and construction facilities. This condition is particularly aggravated in connection with heating and ventilating because of the relative newness of present day practice and rapid advancements in design.

Many shipbuilders have considered ventilation as a necessary evil. The "when I went to sea we didn't have this" type of thinking has seriously retarded

progress in the past. Ships have been designed time and again with little or no consideration being given to the ventilation requirements. Further, the handicaps caused by the lack of pre-planning are far greater in shipbuilding than on land, since windows, roofs, or sub-basements are not available for utilization. It is gratifying to say, however, that today most naval architects realize the importance of ventilation, and that greater consideration is now being given to it in the design stage.

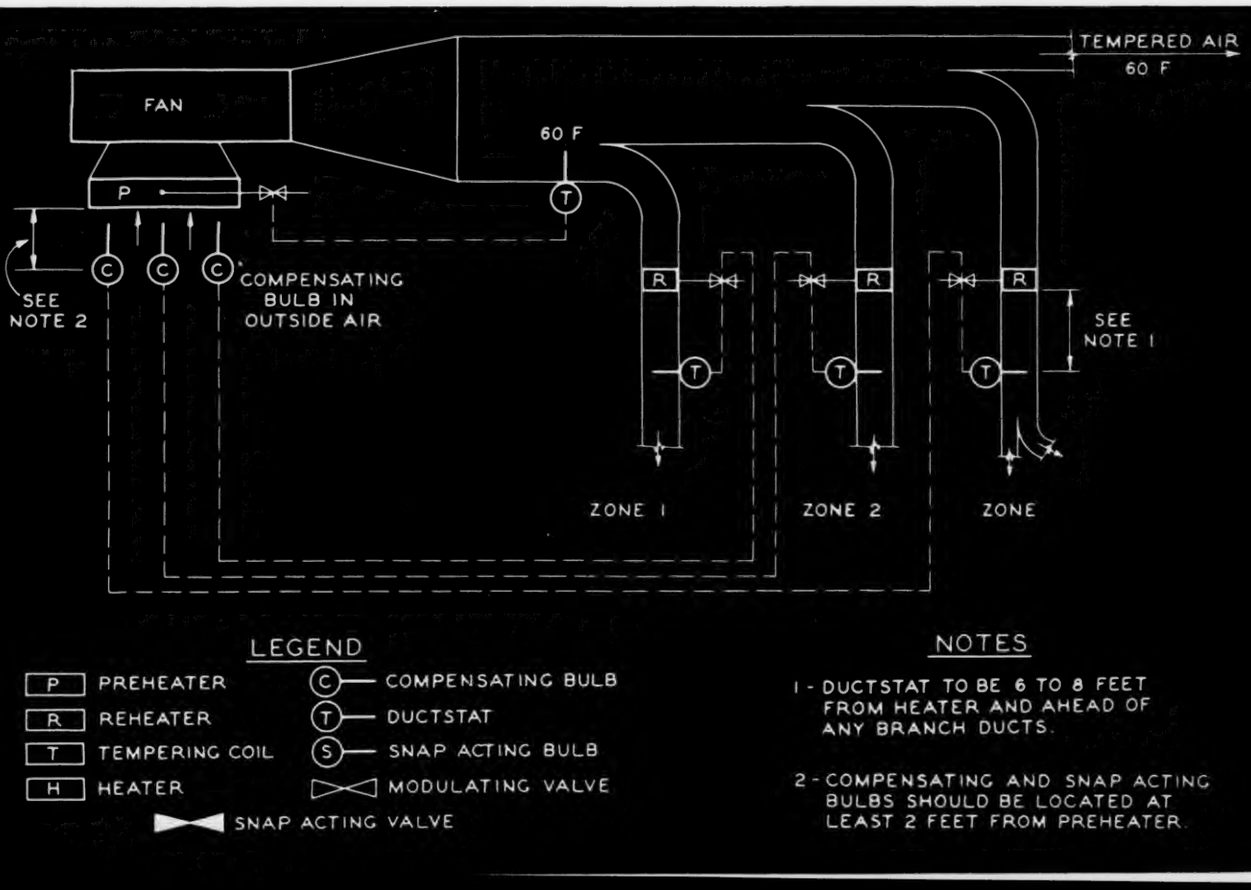
A ship may be defined as a vehicle for carrying people and merchandise on water. The vehicle is designed with certain limitations in mind, such as the requirements of a particular trade (type and quantity of cargo, cargo handling facilities, passenger traffic, etc.), depth of water available, and economic balance between operating costs and earnings. These considerations must be combined in a single structure so formed that its seaworthiness, propulsion efficiency, and operating efficiency make it possible to compete on a commercial basis. It should be noted that when most ships are designed, their potentialities as naval auxiliaries are carefully weighed. Subsidizing of relatively unprofitable trades is advantageous because of the independence it affords the subsidizing nation in critical war periods when the vessels of other nations are not available.

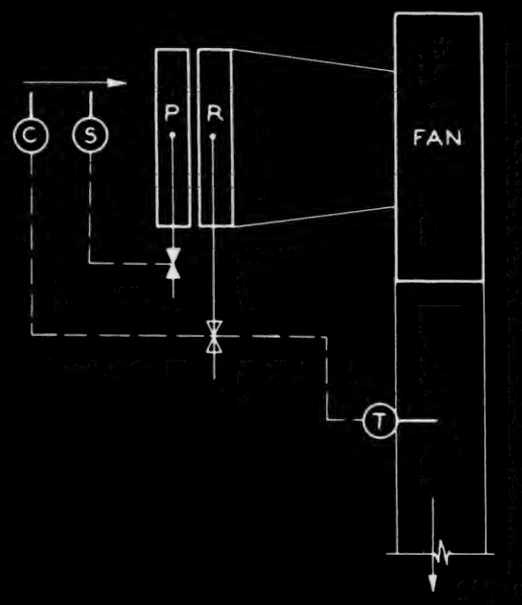
The seaworthiness of the vessel is increased by subdividing the main watertight hull space into a number of watertight compartments. This is usually done on merchant vessels by providing transverse watertight structures (bulkheads) so located along the ship's length that the vessel will not sink even when the shell is pierced in one or more watertight compartments, by collision, torpedoing, or other causes. It is obvious that the watertightness of these bulkheads is very important, particularly under present circumstances, and every effort is made to lead ventilation ducts so that they do not pass through such structures. Where openings must be cut for ventilation or other purposes, special watertight closures are fitted to protect the watertight integrity of the bulkheads.

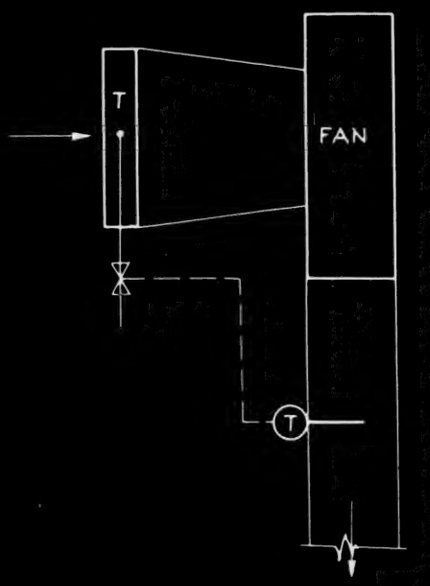
In addition to the main transverse bulkheads, the ship's interior is fitted with decks and flats (floors), that are spaced to suit the use to which the space is put. The deck height (floor height) in cargo spaces generally varies from 9 ft to 30 ft. This height in living quarters varies from 7½ ft to 9 ft. Usually in main machinery spaces, the entire depth is subdivided only by a few flats (partial decks), and gratings are provided where necessary to service the equipment.

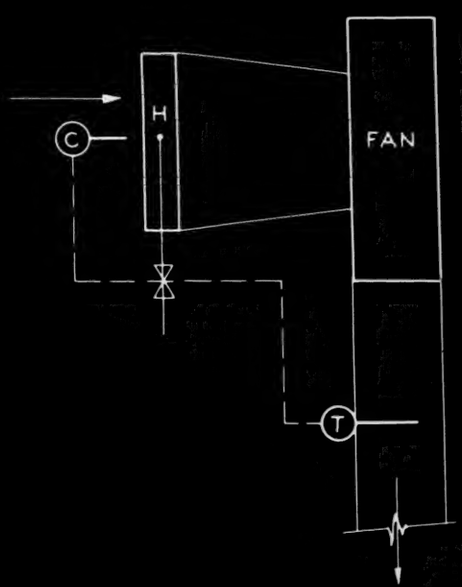
Bulkheads, shell, and decks are designed to suit structural as well as watertight requirements of the vessel. Beams, stiffeners, stanchions, brackets, and similar structures are to be contended with. Fig. 1 indicates the arrangement of a typical cargo vessel, and also shows the main transverse watertight bulkheads, decks, structural members, and many other pertinent characteristics. Living quarters are usually located on and above the weather deck, this custom being based on the assumption that better natural

Fig. 2. Zone system commonly used on U. S. Maritime Commission vessels.









air and light are available in this location. It is obvious that the upper 'tween deck and other spaces can be conveniently used for additional living and working spaces, but that natural ventilation is far less effective in this case.

The foregoing description mentions some of the limits and natural boundaries which affect the design and layout of ventilation and heating systems. It should be added that there is also equipment, wireways, and miscellaneous piping which must be considered. Since there is very little unassigned space, fan rooms are usually quite congested and many studies must be made to ascertain which arrangement of equipment will best suit the conditions at hand. Cuts in structural members must be limited in number and size. Lack of headroom often causes poor aspect ratios, inaccessibility, and other undesirable conditions. It therefore follows that the design of a ship's heating and ventilation systems is far more than a theoretical calculation. A good designer must be familiar with all phases of ship construction and operation in order to provide sufficient and efficient ventilation and heating, and also to locate his equipment where it will interfere least with basic arrangements, major equipment, stability, and other important factors.

Ventilation and Heating Requirements

Factors governing ventilation requirements are the same whether on land or sea. Temperature rise in living quarters is usually limited to 10F, and in working areas 15F, above that of the supply air.* Usually the air requirements are estimated on the basis of air change, and then checked for excessive temperature rise. Heating must be considered, of course, if the system is also used for that purpose. In crowded spaces it is common to base the ventilation requirements on the occupancy anticipated. This method must also be checked with temperature rise estimates. 25-50 cfm per occupant is usually provided. Table 1 shows typical ventilation and heating practices for Maritime Commission vessels.

The design outside air temperature for heating is usually selected as 0F or 10F. These temperatures are low enough to include a fair factor of safety, as average winter temperature at sea is about 30F. For this reason, use of additional factors of safety,

*The term *temperature rise*, where only ventilation (no refrigeration) is concerned, has puzzled many people who are familiar only with air conditioning in which the designed room temperature is lower than that of the designed outside air temperature.

Fig. 3. (Top) Central system—separate preheater and reheater; Fig. 4 (Center) Tempering air system; Fig. 5 (Bottom) Central system—one heater.

This article applies to vessels designed and constructed for the United States Maritime Commission, and is presented here with the cooperation and approval of the Maritime Commission.

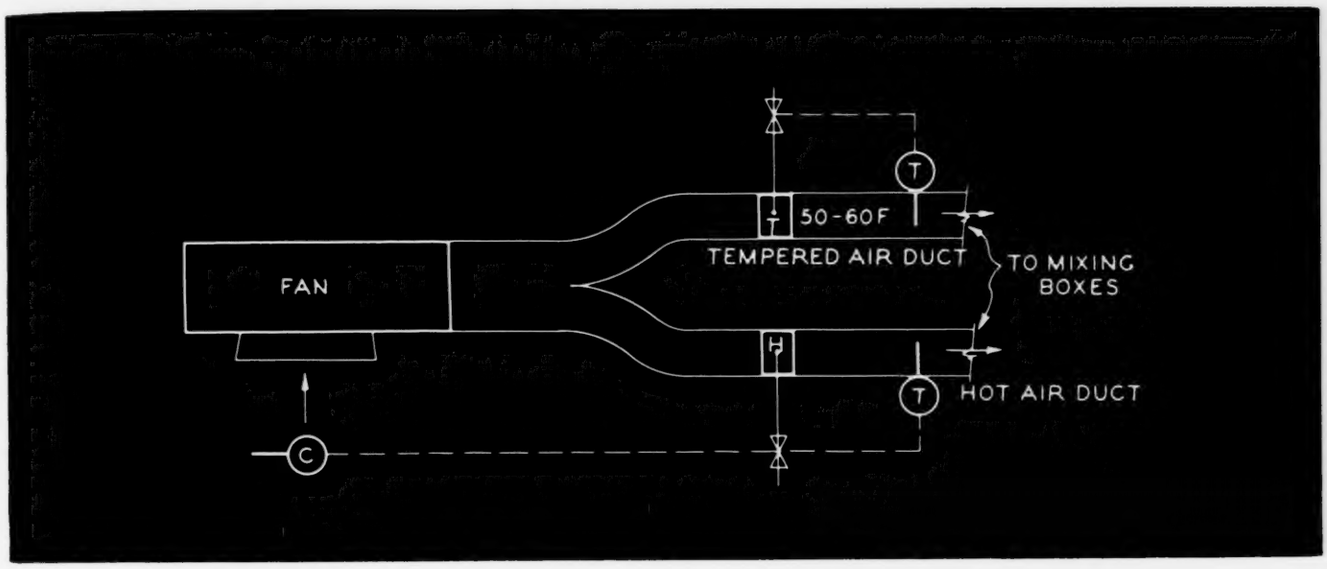


Fig. 6. Dual duct system—parallel heaters.

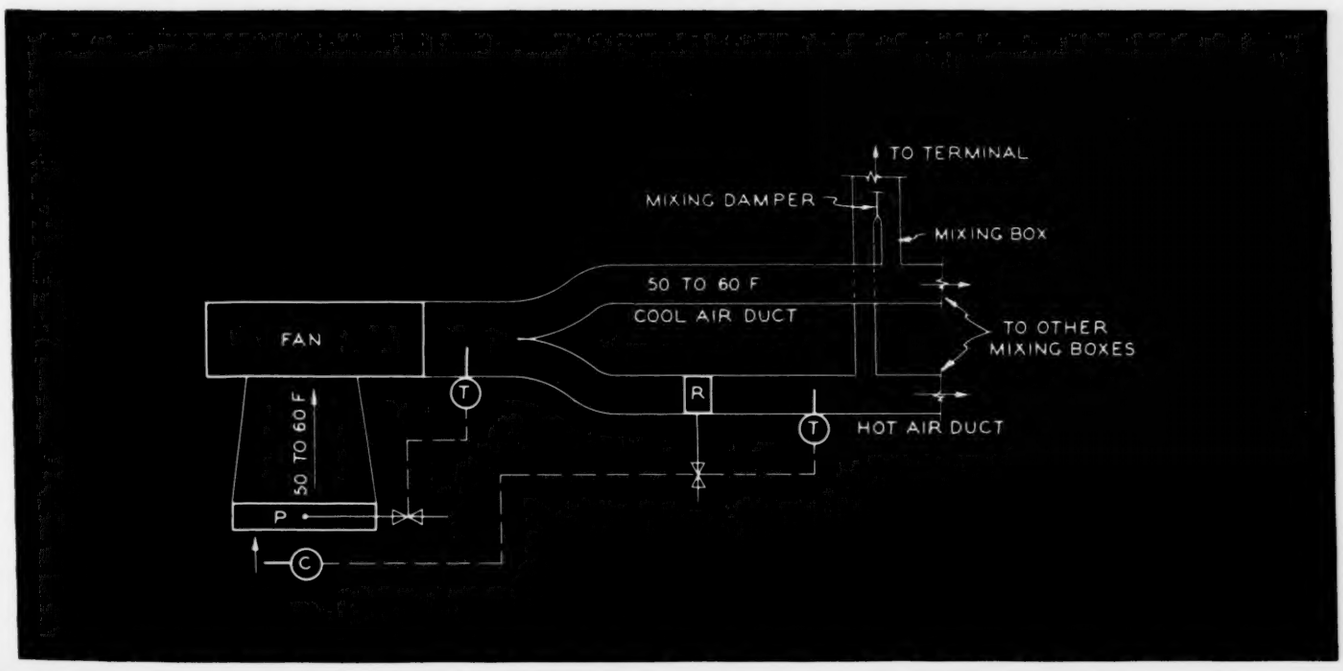
exposure factors, and other margins is in most cases discouraged. In crowded spaces, such as mess rooms and berthing spaces, the internal heat load is frequently in excess of the designed transmission losses, and "cooling" is required. In view of the fact that 100% occupancy is not possible at all times, the internal load is usually estimated with 50% occupancy.

Heating requirements are commonly based on 70F inside temperature, except for the following:

Hospital Spaces	75F
Working Spaces	60F
Passageways and Stairwells	65F
Steering Gear Room	50F

The estimating of overall coefficients of heat transfer is of interest as there are several characteristics peculiar to the ship's structure which do not exist on land. First, the conductivity of steel is

Fig. 7. Dual duct system—series heaters.



Crews Quarters	5-6				H.B. or D.R.	
Toilets and Showers		3-4			D.R.	
Chart House	5-6				H.B. or D.R.	
Passenger and Officers Quarters	4-6				H.B. or D.R.	
Office and Similar Spaces	5-6				H.B. or D.R.	
Mess Rooms	4-6				H.B. or D.R.	Exhaust through galley and pantry
Dining Saloons	3-6				H.B. or D.R.	Exhaust through galley and pantry
Galley and Pantry	3-6	1-2			—	Tempered supply air
Deck Pantries	4-6	3-4			H.B. or D.R.	No cooking equipment
Fan Rooms		Sup. or Exh.	Exh. or Sup.		—	15F temp. rise
Stores Spaces (adjacent to living quarters)	15-20				—	
Stores Spaces (isolated spaces)			Yes	Yes	—	Cowl supply and gooseneck or mushroom exhaust
Hospital Spaces	4	4			H.B. or D.R.	
Soiled Linen and Oilskin Lockers		15-20			—	
Shops	6-10				H.B. or D.R.	Mech. exh. may be required if heat given off from equipment is great
Group Berthing Spaces	Yes	50% Sup.			50% Sup. H.B.	25 cfm per berth
CO_2 Bottle Space		10	Yes		—	
Battery Room		2	Yes		—	
Laundry	2-4	1-4			—	Tempered air sup.
Dry Cargo Holds (Mechanical Ventilation)	20-30			Yes	—	
Dry Cargo Holds (Natural Ventilation)			15	Yes	—	Cowl supply and gooseneck or mushroom exhaust
Steering Gear Space (Mechanical Ventilation)	6-10	Sup. or Exh.	Exh. or Sup.		H.B. or Unit Heater	
Steering Gear Space (Natural Ventilation)			2-4	Yes	Unit Heater	Cowl supply and gooseneck or mushroom exhaust
Dry Stores	6-10			Yes	—	
Gyro Room	3-6	Sup. or Exh.	Exh. or Sup.		—	15F temp. rise
Theaters and Halls	6-8	Yes			H.B. or D.R.	25 cfm sup. per seat
Passageways		Mechanical or Natural Exhaust			D.R. if required	Supply from adjacent quarters
Engine and Boiler Rooms	1-2	Mechanical or Natural Exhaust			—	
Miscellaneous Machinery	2-4	Mechanical Supply or Exhaust			—	15F temp. rise
Resistor Spaces		Yes			—	15F temp. rise
Stair Wells				Yes	D.R. if required	Exhaust outlet at highest point

NOTE: H.B.—Hot Blast System. D.R.—Direct Radiation.

2-spare	Forward Bhd.	64	.15	70	670			
	Dk. Bel.	112	1.0	50	5600			
					6270	175	225	200
2-spare	Same as 2 sp.	(p)			6270	175	225	200
Steward	Front and Side	160	.15	70	1680			
	Dk. Bel.	100	1.0	50	5000			
					6680	160	240	225
2-cadets	Side	72	.15	70	750			
	Dk. Bel.	72	1.0	50	3600			
					4350	145	155	150
Elect. and Sp.	Side and Rear	144	.15	70	1510			
	Dk. Bel.	100	1.0	30	3000			
					4510	160	160	175
2nd Asst. Eng.	Side and Front	144	.15	70	1510			
	Dk. Bel.	100	.10	30	300			
	Dk. Over	20	.30	70	420			
					2230	145	80	125
Jr. 3rd Asst. Eng.	Side	75	.15	70	790			
	Dk. Bel.	100	.10	30	300			
	Dk. Over	90	.30	70	1890			
					2980	145	105	125
Jr. 3rd Asst. Eng.	Same as Jr. 3rd Asst. Eng.				2980	145	105	125
1st Asst. Eng.	Side and Front	176	.15	70	1850			
	Dk. Over	100	.30	70	2100			
	Dk. Bel.	20	1.0	50	1000			
					4950	150	180	175
3-Mess	Aft. Bhd.	64	.15	70	670			
	Dk. Above	16	.30	70	340			
	Dk. Bel.	16	1.0	50	800			
					1810	140	65	125
ZONE TOTAL					43,030	1540		1625

Q_e is the volume in cfm required to obtain an air change every 6 minutes: that is, volume of the space to be heated $\times \frac{10}{60}$ or $\frac{V}{6}$, V not being shown separately here. Q_h for an individual space $= \frac{Q_e \text{ total for zone}}{H \text{ total for zone}} \times H$ for individual space.

Q_d is then selected to balance the difference between Q_h and Q_e for each individual space; and taken at the nearest 25 cfm, such as 100, 125, 150, etc.

To heat the ventilation air (Q_d = 1625 cfm) at design temperatures (0 to 70F) there would be required .018 × 1625 × 60 × 70 = 123,000 Btu per hr, approximately, without volume reduction.

To determine the temperature of the air supplied to the room with 50% of ventilation air: 1625 × .50 × 1.08 (T − 70) = 43,030, where 1625 is Q_d, 1.08 = conversion factor including specific heat, density, and time; and T = outlet air temperature. Solving, the temperature differential (T − 70) is 49F, and T = 119F. This is the final temperature at the reheater.

The temperature rise, then, with 813 cfm, would be from 0F to 60F at the preheater and 60F to 119F at the reheater.

very high and therefore is neglected. Also, the resistance of the outside film coefficient is frequently neglected as it is small compared with that of the insulation and sheathing in many cases. In addition, the stiffening members (on bulkheads, deck, and shell) act as fins and have a considerable effect on the rate of heat transfer. The foregoing considerations preclude the direct adaptation of standard heat transfer data to marine structures.

Heating Systems

The means of heating spaces are the same as those used on land, except that an effort is made to simplify the equipment, since specially-trained ventilation and heating engineers are not available on board most ships.

Fig. 2 shows a Zone System which is commonly used. A single preheater is located at the fan intake, thermostatically controlled to deliver tempered air at 60F. The heated spaces are divided in zones, depending on their location, exposures, type of occupancy, and other factors which govern the heating loads.

The reheater controls are straight-line compensated, delivering 70F air at 70F outside temperature, and the maximum zone hot air temperature at 0F outside temperature. The compensating bulb is located at the fan room intake louver (if the fan room is used as a plenum chamber), in the fresh air duct, or on the weather side of that bulkhead which forms the chief exposure of the zone served. If any of the spaces are large enough to justify a separate reheater, the same arrangement exists except that a room thermostat would be provided in lieu of the compensated duct thermostat. Also, for a more refined system, i. e., for passenger vessels, a separate reheater or booster coil would be provided for each space.

Fig. 3 shows a Central System which is simpler but does not have the refinements of the Zone System. The preheater is usually controlled by a snap acting thermostat set to deliver steam when the outside temperature falls below 35F. The temperature rise of this heater must be carefully selected or overheating is bound to occur during mild weather.

This complication can be avoided by using the system shown in Fig. 2 with a single reheater. Obviously this arrangement will be less compact than that shown in Fig. 3. The temperature rise of the preheater is selected to prevent freezing of the reheater, being in the range of 35F to 50F. The reheater control functions the same as that for the zone reheaters shown in Fig. 2.

A Tempered Air System is shown in Fig. 4. This system is used where working spaces do not require heat or where spaces are heated by direct radiation. The air temperature required for working spaces varies from 50F to 60F. For heated spaces this

Fig. 8. Part of the Cargocaire system, showing the silica-gel beds, Research Products filter, and positive-pressure blower. A Penn pressure control can be seen.

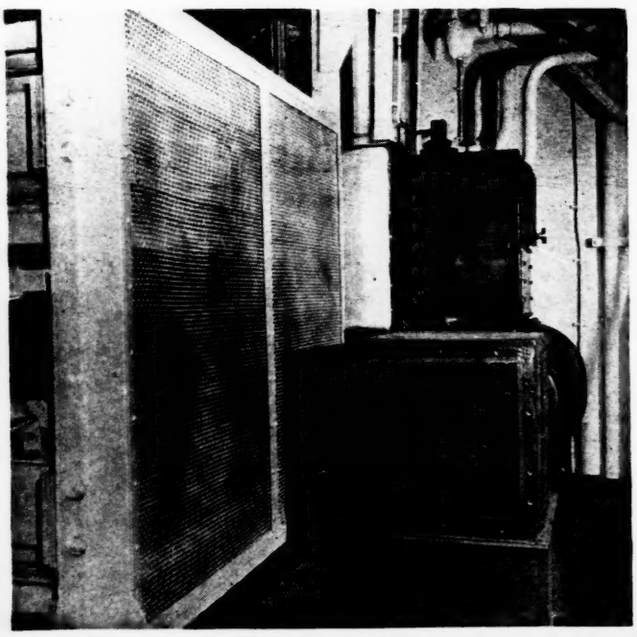
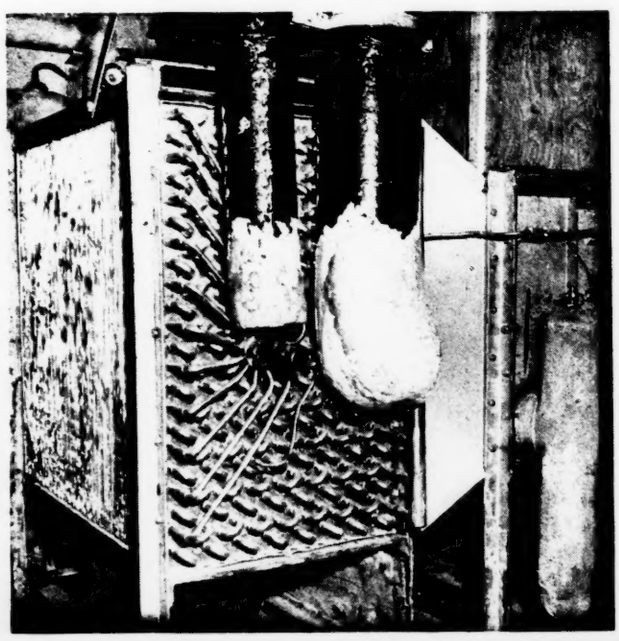


Fig. 9. Nesbitt direct-expansion cooling coils for the refrigerated cargo space. At the right is a steam heating coil which must be used under certain circumstances.



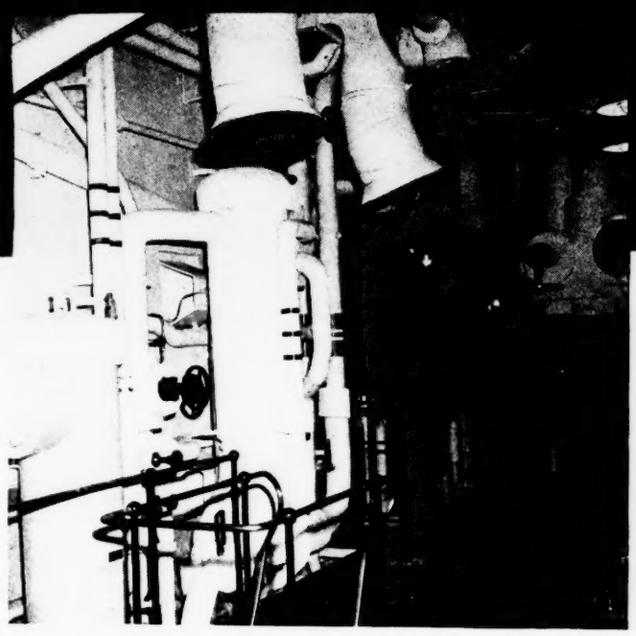


Fig. 10. View of the engine room operating platform showing directional supply terminals and overhead ducts.

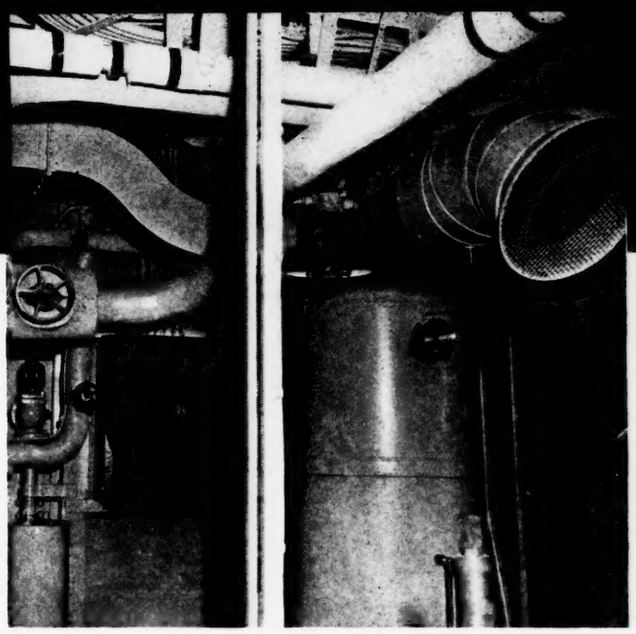


Fig. 11. This illustration brings out clearly the interference encountered by ductwork in a ship.

temperature is usually between 70F and 80F. It should be noted that tempered air can be furnished with the arrangement shown in Fig. 2, if the reheaters or booster coils are by-passed. This is commonly done with air supplied to galleys, laundries, and similar spaces, when the volume is not sufficiently large to justify a separate system for these spaces.

Fig. 5 illustrates an arrangement which is a simplification of Fig. 3 and has been used to save critical materials. It is obvious that with this system particular attention must be given to the sizing of the thermostat controls. Oversizing will probably cause cycling (alternate blasts of hot and cold air) and freezing of the heater.

Figs. 6 and 7 are shown as a matter of interest, as they are used almost exclusively for passenger accommodations. These arrangements are known as Dual Duct Systems and were popular before suitable thermostatic controls were perfected. This system permits the selection of volumes of hot and cold air to suit the requirements of the individual occupying the space. Numerous construction problems plus space limitations have in general made this system unpopular. The present trend is to use the Split System (tempered air and direct radiation) or the Unit System (central preheater and separate boosters for each space) for passenger spaces and Zone Systems for crews spaces. The cold air in dual duct heating systems is constant and is usually between

Fig. 12 A resistor house showing the Diehl ventilating exhaust fan with water-tight cover on weather bulkhead.

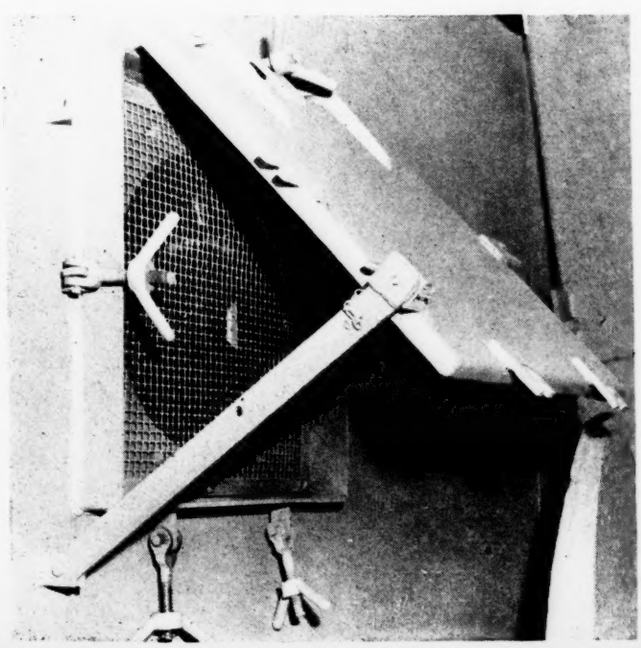
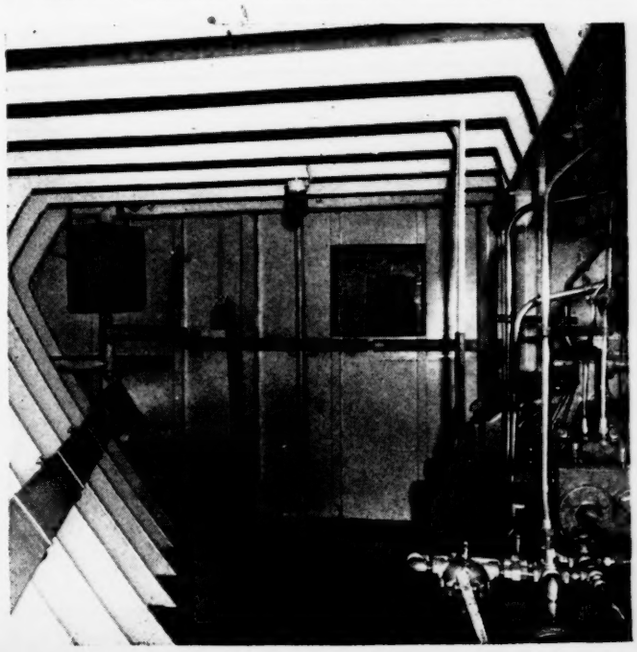


Fig. 13. A Modine unit heater in the steering gear room. The large output and compactness make unit heaters particularly adaptable for this application.



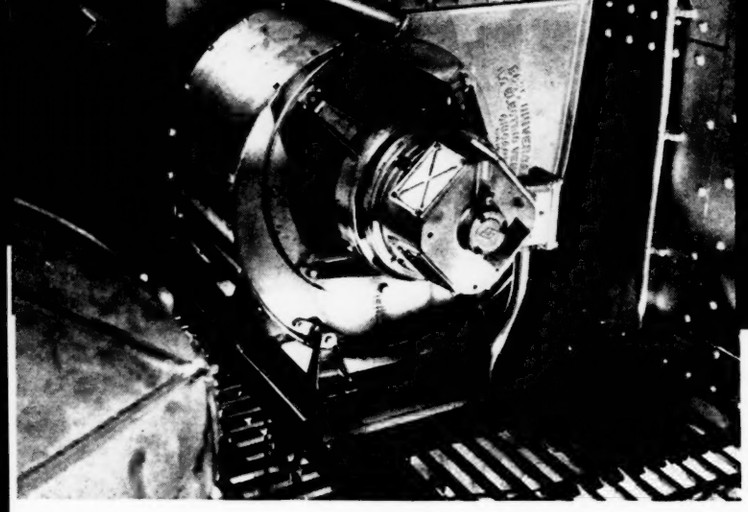


Fig. 14. An IIg direct-connected blower exhausting from machinery space. Welded steel construction is commonly used today.

50F and 60F. The hot air temperature is controlled to vary with the outside temperature, the minimum being delivered at 70F outside temperature and the maximum at about 30F outside temperature. The relation between the cold and hot air supplied to a space is such that the mixture will satisfy the design heating requirements down to about 30F outside temperature. This, of course, means that when the outside temperature falls below this point, throttling of the cold air is required to satisfy the heating load. Obviously, the hot air volume and temperature must be large enough to satisfy the heating load at the minimum designed temperature (usually 0F).

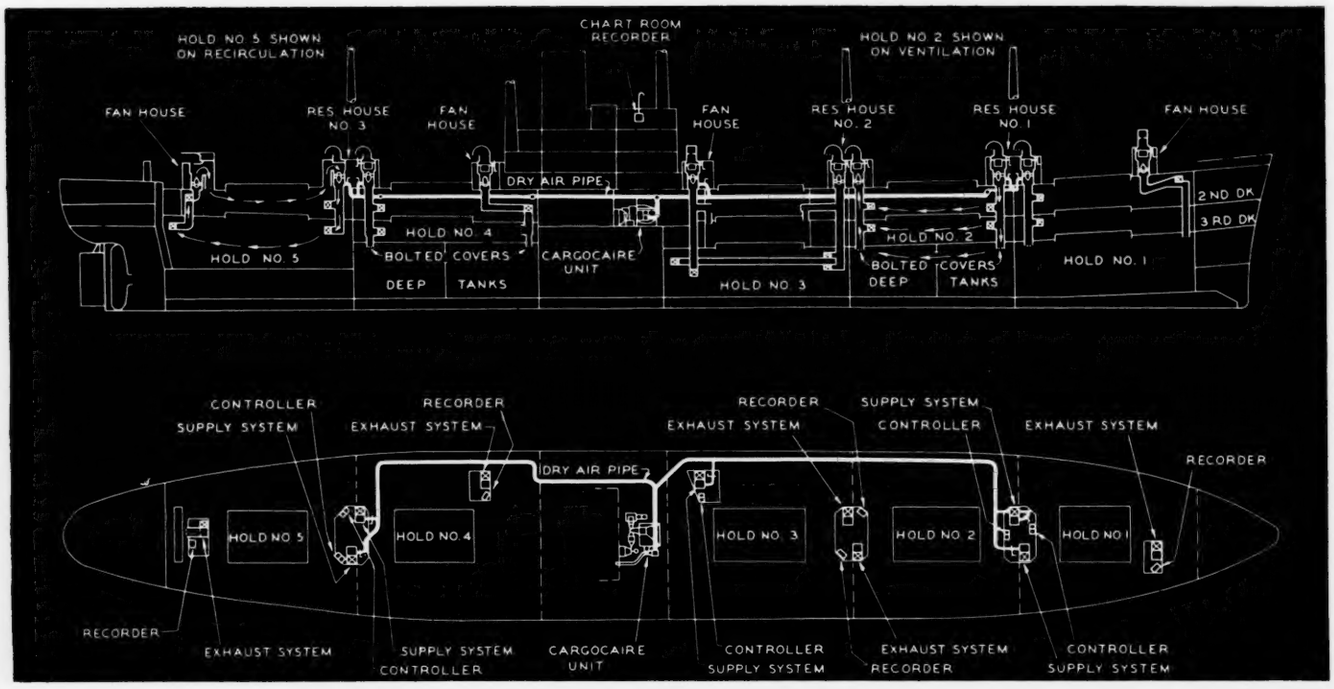
Proponents of the dual duct system emphasize the point that this system is superior to the zone system, because a constant volume of ventilation air is provided at all times except when unusually low outside temperatures exist. It should be noted, however, that ventilation air quantities are usually based on the "cooling" load (temperature rise), and that the amount of ventilation air required for physiological reasons is comparatively small. Also, odors are more prevalent at hot weather temperatures than at relatively cool room temperatures occurring during the heating cycle. It is evident that the latter does not apply to smoking rooms, dining rooms, and other large public spaces. However, as these spaces are not provided with dual duct systems, they are irrelevant to this discussion.

All of the systems discussed above heat the ventilation air. In addition to these, natural or mechanical ventilation systems are sometimes provided which do not heat the air, direct radiation (cast iron in most instances) being used for heating when required.

Table 2 shows the calculations required for determining the heater requirements and hot air distribution of a typical heating zone. It should be noted that recirculation is not commonly used on ships because of the possibility of distributing objectionable odors. Speed reduction, however, of 25%, 33%, or 50% is used during the heating season to reduce the total heating load (outside air plus exposures). Supply terminals are fitted with shut-off dampers. The air supply in overheated spaces can be throttled, thus providing additional air for those spaces which are theoretically underheated.

The example in Table 2 is based on 50% speed

Fig. 15. General arrangement of a Cargocaire installation.



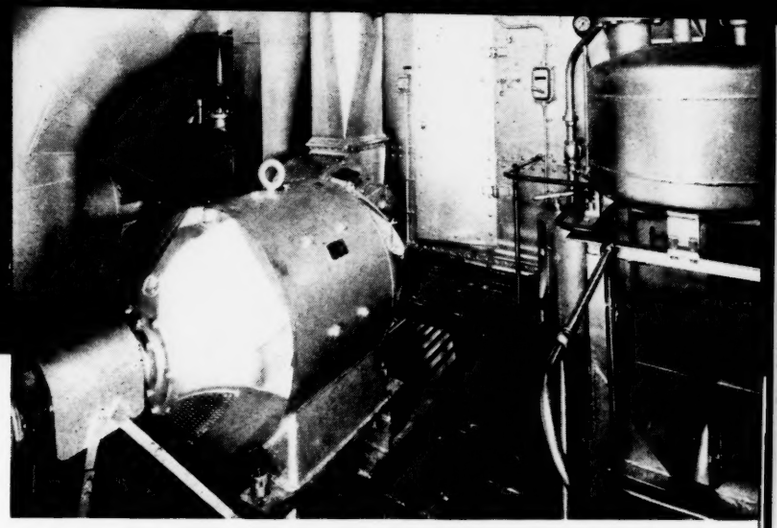


Fig. 16. Direct-connected, ceiling-suspended centrifugal type IIg blower exhausting from Battery Room.

reduction for winter operation. Note that in this example 61,500 Btu per hr are required to heat the outside air from 0F to 70F and 43,030 Btu per hr are required to overcome the losses through cold surfaces. In other words, approximately 60% of the steam consumption is used to heat ventilation air. If there were no speed reduction during the heating cycle, the heat required to bring the cold air up to room temperature would be 123,000 Btu per hr, and approximately 60% more steam would be consumed. While this discussion is elementary, engineers occasionally fail to appreciate the importance of speed reduction where recirculation is not provided.

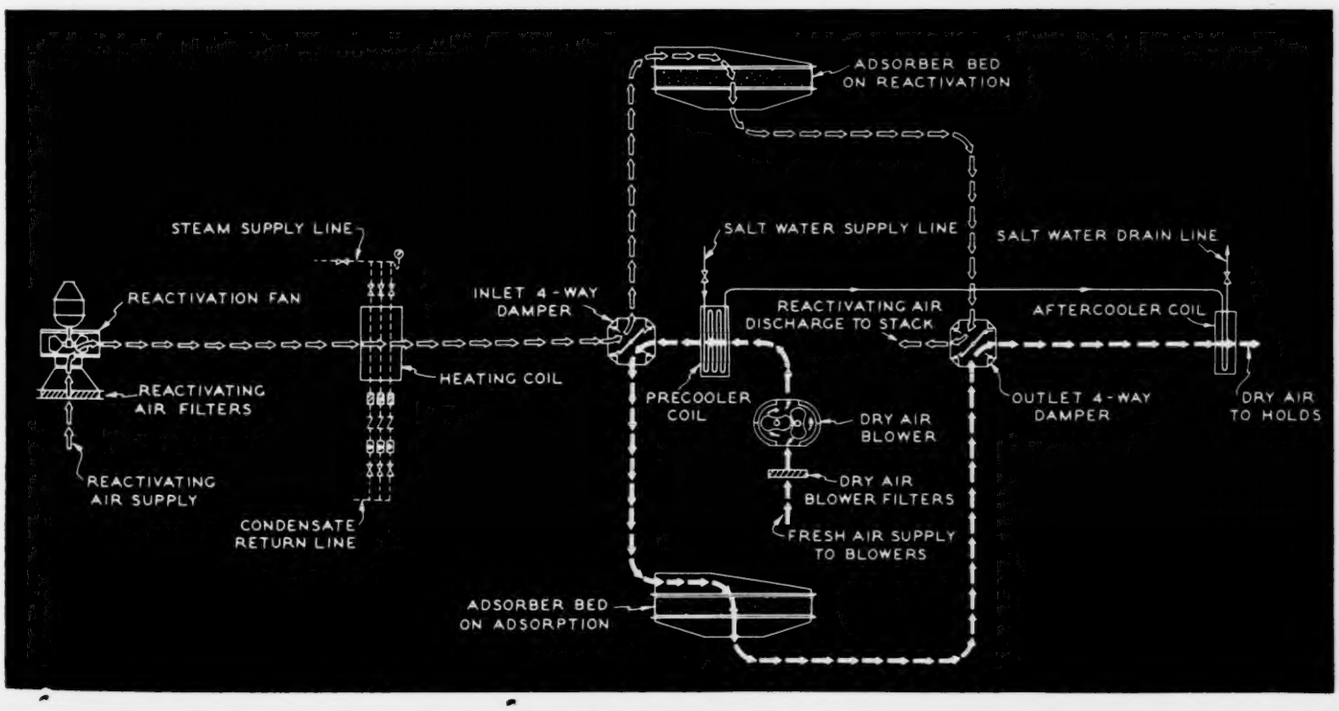
Special Cargo Hold Treatment

A most interesting development in the treatment of dry cargo hold is one which might be classed as process conditioning. This system is used to prevent condensations and high humidity in cargo spaces which would cause rust, corrosion, water damage, mold, tainting, and other damage to many cargoes carried. In order to prevent such damage, a dehumidifying system has been developed which uses silica-gel as the adsorbent and more complete ventilation systems than are normally provided.

The dehumidification equipment consists of a central regenerative unit. Fig. 18 shows a common assembly for such a unit, and Fig. 15 is a diagrammatic plan of the assembly shown in Fig. 18. Steam is used for heating the regenerating air, and salt water is used for precooling and aftercooling. Present systems are designed for a two-hour cycle. The four-way dampers shown are interlocked and manually operated, but future installations may have automatic dampers.

The dehumidified air is distributed to the various hold supply systems by means of a dry air pipe. Fig. 17 shows a schematic arrangement of this pipe and hold system. It should be noted that each hold has a mechanical supply and exhaust system. The recirculation damper is used for switching from ventilation to recirculation. Recirculation is used when the dew point of the outside air is higher than that in the hold. Dry air is injected into the system at this time. Ventilation is used when the dew point of the outside air is lower than that in the hold.

Fig. 17. Schematic diagram showing air flow in the Cargocaire system.



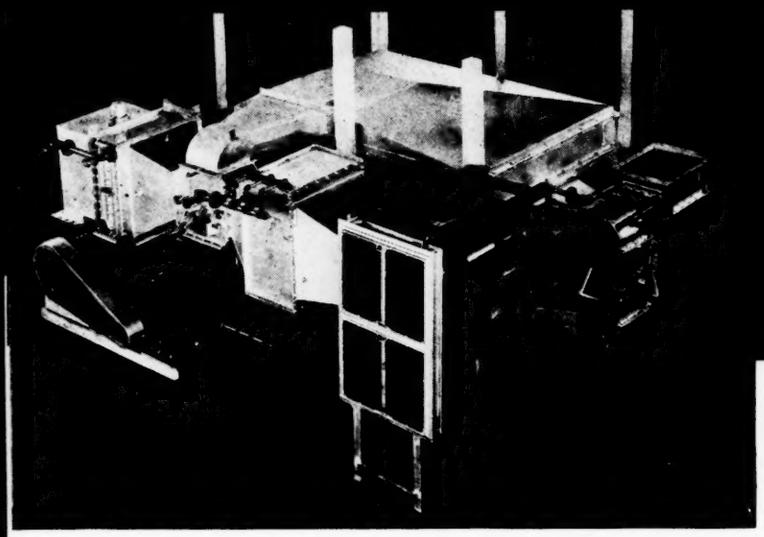


Fig. 18. (Left) A Cargocaire unit, with adsorber bed in the background, heating coil in the center, dry air blower and precooler coil at the left, reactivating fan and filters in the foreground, and aftercooler coil at the right.

Fig. 19. (Below) A bank of American grease filters in the exhaust hood over a galley range.

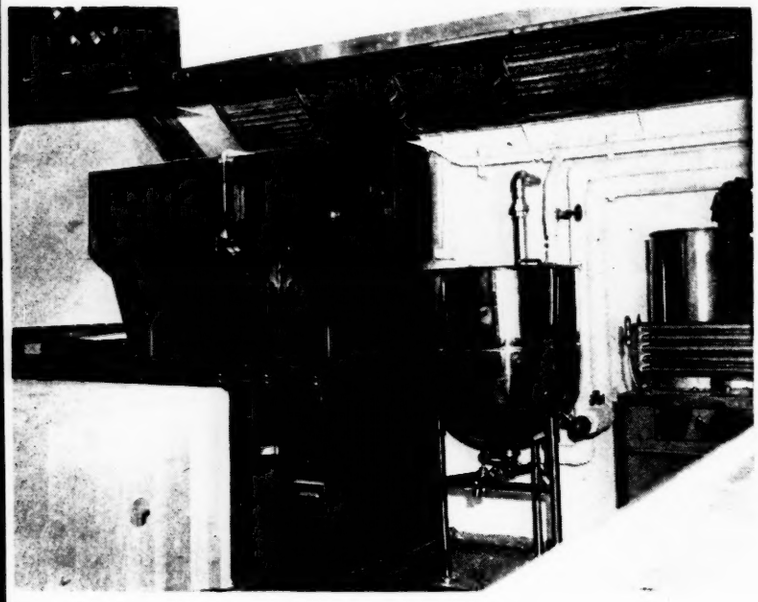
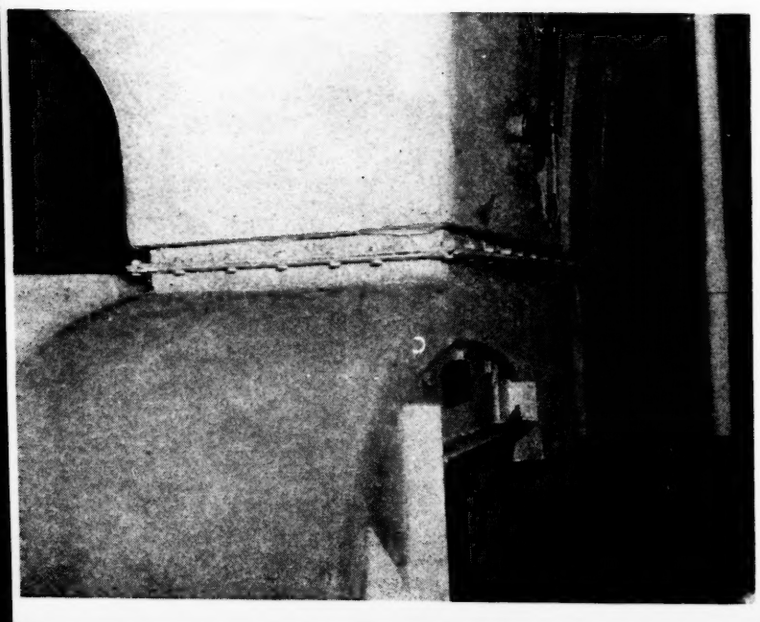


Fig. 20. (Below) Close-up in a quarters fan room showing the American blowers and Diehl motors. Overhead are shown the duct thermometers and Fulton Sylphon duct thermostats which control the steam supply to Modine preheaters with steam distributing tubes.



When particularly rapid drying is required, dry air and ventilation are used simultaneously. Recorders are used to obtain the dry bulb and relative humidity of the outside air and hold spaces. These records are not only important to the satisfactory operation of the system, but they also provide psychrometric data for future designs.

While the above system was originally devised for the protection of general peace-time cargoes, there are definite indications that the advantages are considerably greater under war conditions, particularly for certain military cargoes.

Equipment

Fans and Motors. Three types of fans are commonly used in marine practice—centrifugal, axial flow, and propeller (sometimes called low-pressure or modified axial flow). Centrifugal fans are fitted with either backward or forward curved blades, the latter being confined to fans handling less than 2000 cfm. Axial flow fans are non-overloading and are fitted with integral housings and guide vanes. The wheel has air-foil section blades and is usually cast aluminum. Centrifugal and axial flow fans in most cases require static pressures between 1 inch and 3 inches, although in some instances higher pressures are required. The propeller fans are used principally where static pressures are less than ½ inch, though they have been furnished up to 1 inch.

There appears to be a general tendency to increase tip speeds and outlet velocities to conserve materials. Normally 8000 fpm tip speed was the maximum permitted. This maximum has been raised to 9000 fpm, with 10,000 fpm in special cases where noise is of no particular importance. The maximum outlet velocity has been increased from 1800 fpm to 2500 fpm. Velocities as high as 3000 fpm are used for systems serving machinery spaces and other spaces having relatively high ambient noise levels.

Motors are directly connected to the fan wheels in all but certain special applications. Speed reduction is usually provided for motors on fans supplying heated air, or serving main machinery spaces. Exhaust fan motors are provided with speed reduction only where necessary to balance reductions in

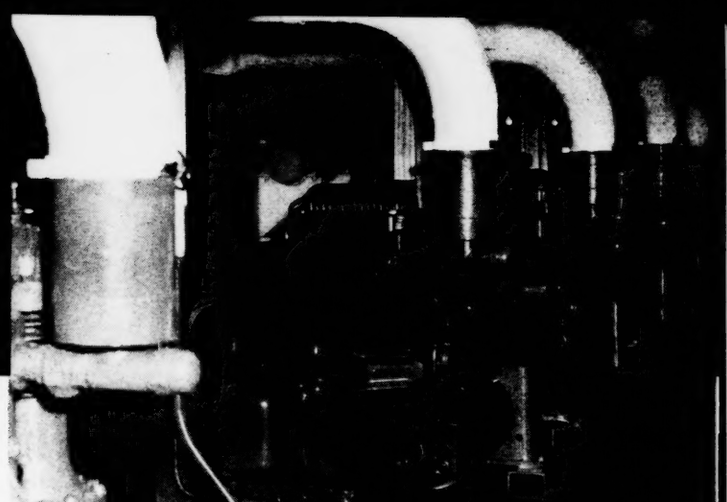


Fig. 21. (Right) Seven York compressor units serving refrigerated cargo spaces. Also shown are the directional terminals through which air is supplied to this area.

supply air during the heating cycle. Most ships are provided only with direct current, and for this reason particular care must be given to locate the motors in accessible positions. Gyroscopic action due to the ship's motion may cause excessive wear on bearings unless they are installed with the axis of rotation fore and aft. Motors are selected for 40C ambient temperature unless exposed to exceptional high temperatures, in which case, they are selected for 50C ambient temperature. At present there appears to be a tendency towards using armature control on motors requiring 50% speed reduction, as reduction by field control, commonly used, requires considerable additional critical materials. It also appears that a further saving can be obtained by using a fixed armature resistance to provide operation at only 50% and 100% maximum speed.

The trend towards axial flow fans has been curtailed due to the fact that they are not always available for use on non-combatant vessels. This type of fan is relatively new in this country, but compactness and high efficiency make it particularly adaptable to ship work, particularly where quiet operation is not essential.

Propeller fans with integral, flanged housings are preferred. The casing is considered essential to safe and efficient operation, as it protects the fan and operating personnel and also provides a definite tip clearance. In addition, it is equally and easily adaptable to both duct and bulkhead installations.

Fans are usually constructed of steel (plates, angles, and castings), and arc welding is commonly used for assembly. Spark-proof fans and those handling corrosive frames must be constructed of special materials. Non-rotating parts are at least ⅛ inch thick, with the following exceptions for centrifugal fans having pedestal motor mountings:

	Minimum U. S. S. Gauge		
Wheel Dia., Inches	Casing	Bowl	Inlet Cone
6 and less	16	16	16
6½ to 12	14	14	14
12 to 24	12	14	14

Casings, foundations, and wheel assemblies are hot-dipped galvanized. One-half inch draincocks and clean-out plates are provided on centrifugal

Fig. 22. (Below) A resistor house showing goosenecks on top which supply air to the cargo hold system.

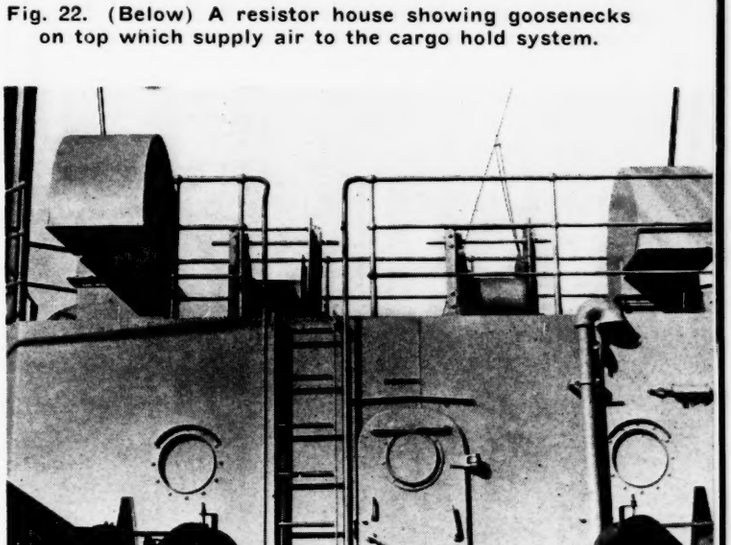
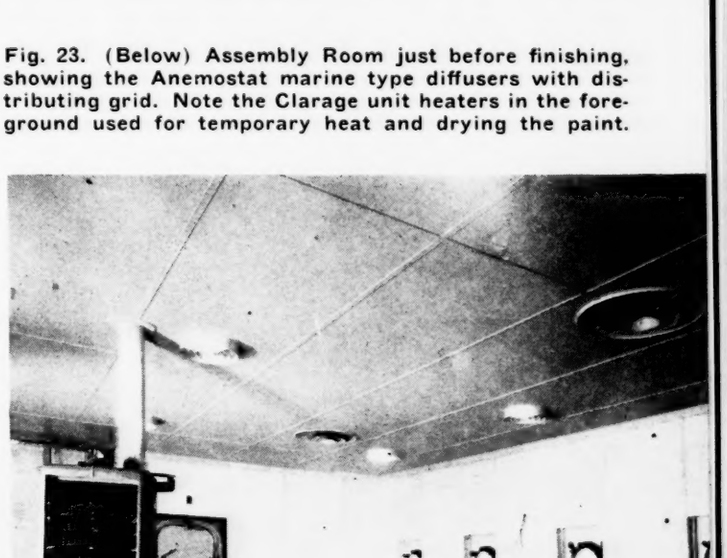


Fig. 23. (Below) Assembly Room just before finishing, showing the Anemostat marine type diffusers with distributing grid. Note the Clarage unit heaters in the foreground used for temporary heat and drying the paint.



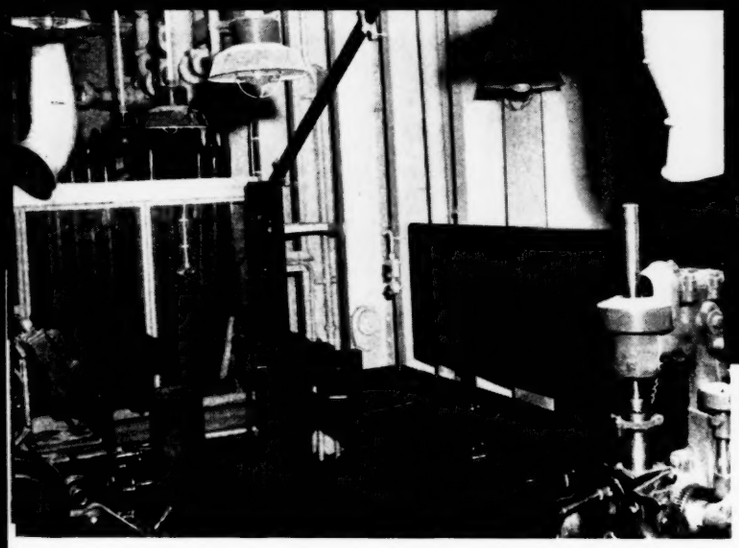


Fig. 24. Portion of the machine shop with one of the directional supply terminals at the upper left.

fans. Hinged covers and lubrication fittings are mounted on the outside of axial and propeller fan housings to provide easy access.

Heat Exchange Surface

Table 1 indicates the common methods for heating. In general, where mechanical supply ventilation is available, hot blast heating is used. Otherwise unit heaters or direct radiation must be provided.

The heating elements of blast coils, unit heaters, and convectors consist of copper fins and tubes. Headers are of copper tubing, bronze castings, or gray cast iron. While cast iron is acceptable, copper or bronze is preferred. Wall-type cast iron radiators are used only on low pressure systems operating at less than 15 lb per sq in gauge.

Blast coils are constructed with two headers and straight or offset tubes. Preheaters have inner tubes and are installed with tubes vertical, and reheaters are installed with tubes vertical (where practicable) or horizontal. To conserve copper, use of inner tube heaters is being discouraged and thermostatic controls are selected to prevent freezing. For the same reason, face velocities and friction drops have been increased. Where previously the values of 650 fpm and 0.35 inch of water (for both heaters) were specified, values of 1200 fpm and 0.50 inch to 0.75 inch of water are now being used. While the use of by-passes is permitted, most designers prefer not to use them because of the complications involved.

Unit heaters are employed for heating large shops, steering gear rooms, and engine spaces on diesel vessels. These units are furnished with two speed motors and face louvers for controlling the air blast, no thermostatic controls being provided for regulating the steam supply.

Convectors are usually of the conventional header type. The enclosures have at least No. 18 U.S.S. gauge fronts and tops and No. 20 U.S.S. gauge sides and backs. Steel enclosures, hot-dipped galvanized or otherwise protected against corrosion from salt air, are provided in most cases. Convectors located in the pilot house, within the fixed magnetic circle of the standard compass, must be constructed of non-ferrous materials. Wall-type models with the grille on top are most common. Sloping tops are recommended to prevent their being used for stowage purposes. Convector radiators, having steel fins and a continuous S-bend copper tube, are used in some cases, but the conventional convector design is preferred particularly for working pressures over 15 lb per sq in, gauge.

Heater Controls. The thermostatic controls provided for the blast coils shown in Figs. 2 to 7, inclusive, are usually of the self-contained or pneumatic type. Electric controls are not widely used because they are usually designed for alternating

Fig. 25. (Left) Fan room supply louvers serving the hot blast heating system for the officers' and crew's quarters. This photograph was taken on a newly painted ship and shows clearly the quantity of dirt that is intercepted by these louvers and the need for filters. Fig. 26. (Center) The hot blast system serving the officers' quarters showing the Fulton Sylphon control in the ducts for the steam valve, the duct thermometer, and the J-M duct insulation. Two Modine zone reheaters can be seen. Fig. 27. (Right) A 24,000 cfm La-Del-Troller axial flow supply fan serving the engine room. Note door for access to motor and lubrication fittings on right side of casing.

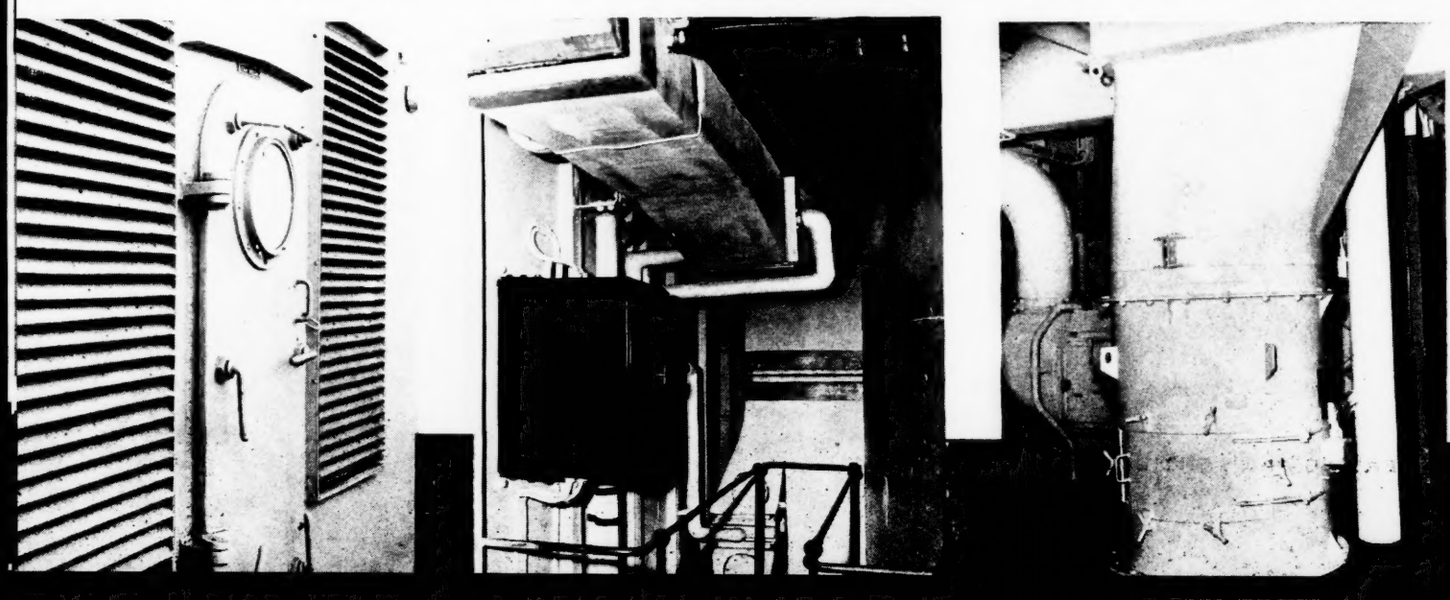


Fig. 28. A partial view of the refrigerated cargo spaces. At the lower left is the inlet to the evaporator above which is the fresh air supply duct from the outside, while overhead are shown the exhaust duct and the cold air circulating supply ducts.

current, the frequent existence of considerable vibration on board ship, and the effect of salt air on contacts. Normally-open valves are used so that any failure will not stop the supply of steam to the heaters. They are usually furnished with bronze bodies and stainless steel poppets and seats.

Valves are usually sized for 10 lb per sq in drop through the valve at full delivery, with 30 lb per sq in at the control valve, assuming 35 lb per sq in gauge pressure on the low side of the reducing valve and about a 5 lb per sq in drop between reducing and thermostatic valve. Because of the general tendency of designers to overestimate heating requirements, it is commonly recommended that the smaller size be used where the design capacity falls between two commercial sizes, and does not greatly exceed that of the smaller size. One common mistake is to size the thermostatic control for the maximum condensate rate of the heating coil. Obviously, poor results will occur with this practice, as in most cases the coils themselves are oversized. The accumulative results are wasteful and inefficient. To say the least, the importance of properly locating thermostatic controls is the same both ashore and afloat and cannot be overemphasized.

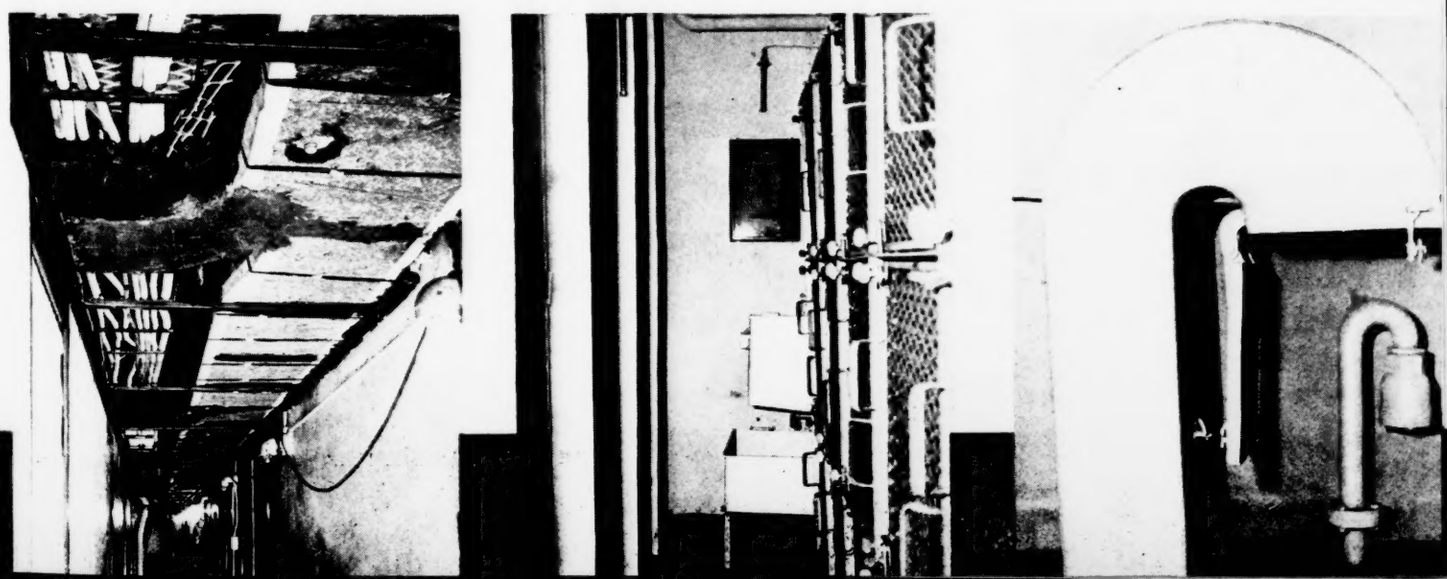
The self-contained regulators are of the modulating type in most cases and operate on the hot-chamber principle. Snap-acting regulators are used where the steam volume is based on anti-freezing requirements only. Conical, characterized-type poppets are provided to give accurate control.

Pneumatic controls are either the bleed or non-bleed type. The air supply is usually furnished by the ship's emergency compressed air systems so that separate compressors are not required.

Thermostatic controls are relatively new for heating systems on merchant ships. It is therefore the practice to encourage the manufacturer to familiarize himself with the installations with which he is concerned. Some manufacturers also are spending considerable time preparing operating instructions pertaining to their equipment, and these are valuable to both designers and the operators. Installation of controls by the manufacturer is also encouraged. On certain equipment, requisitions must include a clause providing for adjustment by the manufacturer before approval will be given. All adjustments must be tamper-proof and the use of by-passes around thermostatic controls is prohibited. As with all other equipments, education of the operating personnel, as well as the designer, is essential if the new equipment is to prove successful. Simplicity is of utmost importance.

Automatic dampers and by-passes have not been used because most of the systems are relatively small

Fig. 29. (Left) View of a passageway before ceiling in. The supply ducts shown serve staterooms. Ducts are insulated with J-M BX-18 insulation. A Young damper regulator can be seen in the near foreground. Fig. 30 (Center) Close-up of a fan room showing at the right a bank of American marine type air filters and, at the rear, part of the cleaning equipment for the filters, and overhead the operating instruction sheet. Note the Fulton Sylphon compensating bulbs for the zone reheater thermostatic valves mounted at the fresh air louvers. Fig. 31. (Right) Rectangular gooseneck exhausting boatswain stores. Note watertight cover.



(10,000 cfm and less). The movement and vibration of the vessel, and the complications accompanying such devices also discourage their use.

Steam Piping and Fittings. Steam heating systems are usually designed for 15 or 35 lb per sq in gauge pressure. In most cases the lower value is confined to systems using cast iron radiation. The designs usually follow good land practice. Particular care must be taken to provide adequate drainage and venting as trim and list vary from time to time with the loading of the vessel. Expansion, too, is more of a problem than on land due to the movement and twisting of the vessel and the relative high steam temperature. Cuts in decks are fitted with watertight stuffing boxes. Extra heavy flanged spools are fitted at watertight bulkheads. Particular care is required to provide a suitable drop and length of cooling leg, due to limitations in deck height and other congestion in fan rooms.

Seamless, lap-welded, or butt-welded steel pipe is used for heating systems. Joints are made up with screwed ground unions where the size is small (1½ inches and less). Steel flanges (screwed or welded) are used for larger sizes. Valves are provided with bronze mountings. Valve bodies are bronze for small sizes and cast iron for larger sizes. Fittings are made of malleable iron for small sizes and cast steel for larger sizes. Under present conditions, substitute materials must be used in many cases.

Pipes are sized according to the available pressure drop and maximum allowable velocity. The maximum velocities for steam and drain piping commonly allowed are expressed by the following formulas:

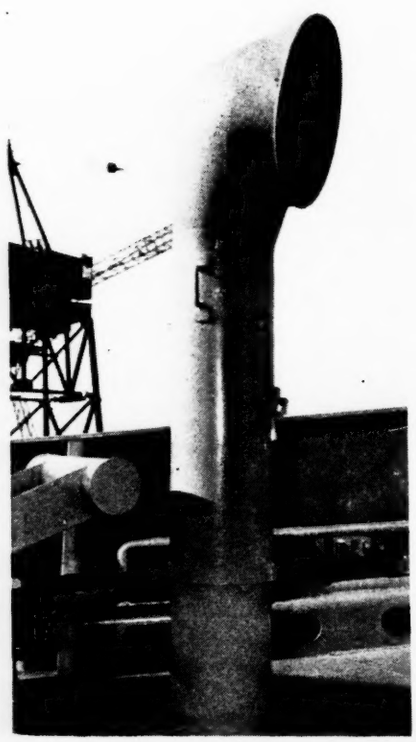
$$V_s = 4860 \sqrt{D} \qquad \text{(For steam piping)}$$

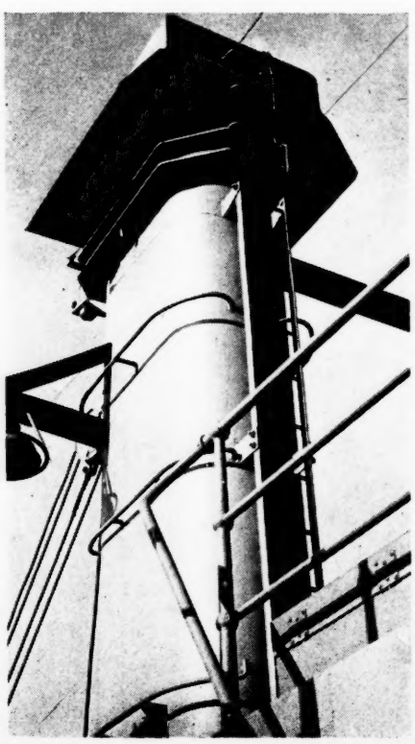
$$V_c = 300 \sqrt{D} \qquad \text{(For condensate piping)}$$

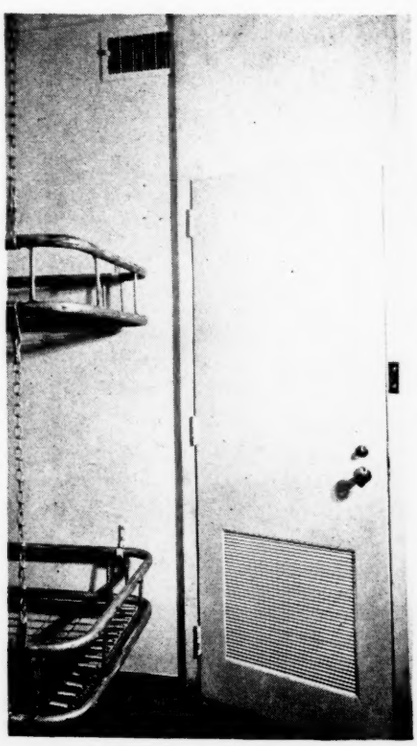
where V_s and V_c = maximum velocity of steam or condensate, in feet per minute, and
D = actual inside diameter of pipe, in inches.

(Note: Pipe sizes less than ½ inch IPS are not recommended, though calculations frequently indicate that such sizes are theoretically adequate.)

Fig. 32. (Left) A typical cowl ventilator with manual fire damper supplying the boatswain stores. Fig. 33. (Center) Ventilator on top of the kingpost. Air entering this ventilator is supplied to the engine room by the fan shown in Fig. 27. Fig. 34. (Right) A typical cabin showing the Waterloo marine type supply registers on the bulkhead and on the door louver for the exhaust of air into the passageway.







In most cases the steam heating system also serves domestic hot water heaters, and equipment in laundries, galleys, and pantries. Condensate is usually lead to an atmospheric drain tank.

Valves are provided on both the steam and drain side of heaters, convectors and radiators. Y-strainers are provided ahead of thermostatic control valves, and dirt pockets or Y-strainers are used to protect steam traps. Float, inverted bucket, or combination traps (with separate condensate and vent features) are usually specified for unit heaters and blast coils. Thermostatic traps are specified for convectors, radiators and other equipment having relatively low condensate rates. Gauges are frequently provided for checking the steam pressure supplied to blast coils.

Steam and return lines (excepting cooling legs) are insulated. Standard thickness insulation, of 85% magnesia, molded amosite asbestos, rock wool, and fibrous glass, are commonly specified. Canvas or fibrous glass is used to lag insulation.

Filters. Successful application of air filters to merchant vessels has greatly progressed but has not been completely perfected. While the necessity for using air filters at sea has frequently been challenged, they serve a very useful purpose while cargo is being handled (particularly those similar to bulk ore, grain, and sulphur), when considerable impurities exist in the atmosphere. Also, soot discharged from the stack is often drawn into fresh air intakes as it falls. In addition, where fan rooms are used as fresh air plenums, flakes of paint and insulation, refuse from repairs, etc., will be drawn into the system unless filters are provided at the entrance to the duct system (not at weather louvers). Furthermore, many ships which originally did not have filters, have been fitted with them after being in service for a while.

Although the importance of air filters is fairly well established, ignorance of their existence, function, and maintenance has seriously hampered their utility. Also the usual arguments regarding the relative merits of throwaway and cleanable filters existed when they were first applied. Throwaway filters in cardboard frames were definitely discarded, because experience proved that even before the vessel left the yard the frames absorbed moisture which dis-

Fig. 35. The sharp slope of this Perkins radiator is due to the curvature of the ship's hull at the stern. Sarco specialties are illustrated.

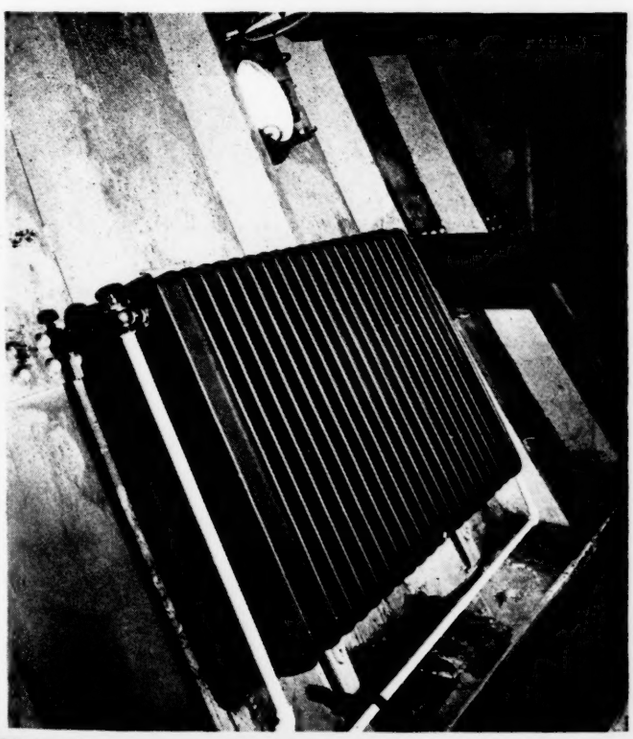


Fig. 36. Close-up of a stack showing the ventilating louvers. In this case the louvers supply air to the engine room ventilation systems.

integrated and warped them, thus making the filters not only useless but dangerous, for the media became loose and was drawn into the system. The possibility of designing a throwaway filter capable of withstanding high humidity salt air was considered, but the idea was discarded when the cost brought it into the price class of the cleanable filter. Also the nuisance of carrying replacements made their use undersirable. Washable filters have, therefore, been adopted.

Washable viscous filters with metal media have been most popular. However, here again certain difficulties have occurred. First, the filters were installed dry in many cases. Obviously their efficiency was so poor that many were condemned by those who did not know their principle of operation. In addition, corrosion frequently destroyed them in a short time, thus creating an additional source of impurities. Even where oiling was done, abrasive dusts (principally from bulk or cargoes) wore away the adhesive coating and electro-galvanizing, and corrosion then finished the job. Therefore it was suggested that all wire mesh filter media be hot-dipped galvanized. An investigation proved that a complete redesign of the conventional metal filter was necessary, as the small mesh could not be successfully galvanized by this method. Since the galvanizing on wire mesh cracks when crimped, specifications now require that each piece be hot-dipped galvanized after all cutting and forming has been finished. Filter and holding frames, of No. 16 and No. 14 U.S.S. gauge sheet steel are also hot-dipped galvanized. Pressure drop is limited to 0.10 inch of water when delivering 800 cfm through

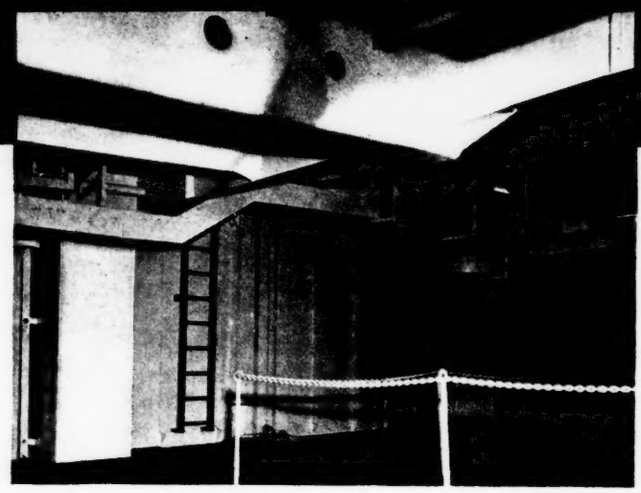


Fig. 37. Exhaust ducts in a cargo hold space. Particular attention is called to the guards which protect the outlets. Similar ducts located at the other end of the hold supply air to this space.

a 20 inch x 20 inch unit. The minimum allowable efficiency is 50%, based on the Bureau of Standards test method using Cottrell precipitate dust. Twenty per cent spare filters are furnished. Because of vibration and shock, use of positive locking devices is required for holding the filter unit in place.

Use of bronze filters has been considered, as the weight and cost of the hot-dipped galvanized filters is relatively high. At present, however, the use of bronze is being limited to an absolute minimum, and, therefore, its use for filters has not been encouraged.

Possibly the most important reason for unsatisfactory filter operation is the fact that little or no effort was made to inform the operating personnel of the filters' existence or function. Frequently washable filters were installed and no maintenance equipment or cleaning instructions were provided, nor were spares furnished. Cleaning and re-oiling equipment, spares and oil are now considered standard equipment for all vessels having washable viscous filters. Dipping has proven the most efficient method for re-oiling filters.

One shipping company had difficulty in deciding whether the deck or engine department should service the filters—dry, spun-glass type in this case. The problem was solved by having the manufacturer clean and service the equipment whenever a vessel docked at the home port. Naturally this arrangement is only possible when voyages are regular and relatively short so that little chance of overloading the filters exists.

Outlets. There are many different types of ventilation outlets used on merchant ships. These may be divided into two classes; namely, exterior (weather)

Fig. 38. A typical toilet showing the mechanical exhaust ductwork, Young regulator, Waterloo grilles, and a Shaw (Shaw-Perkins) radiator.

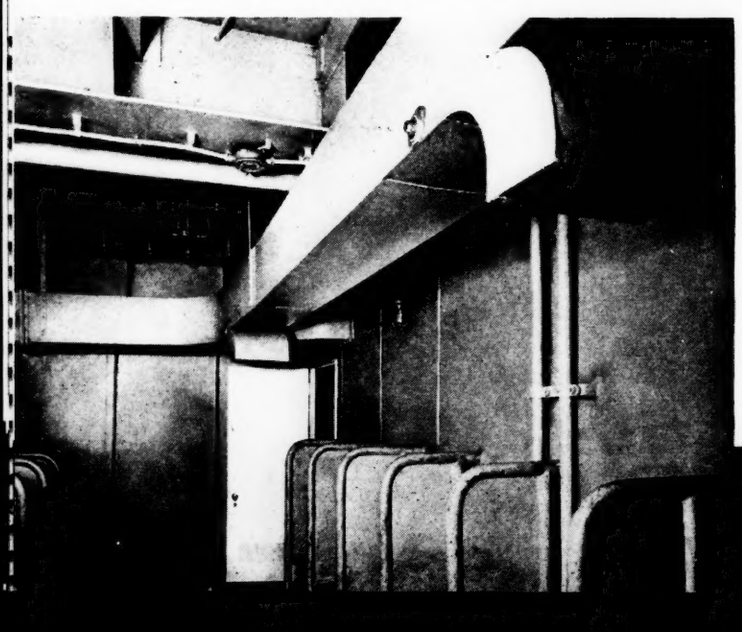


Fig. 39. View showing special adjustable rectangular diffusers used for ventilating and heating the lounge on a passenger vessel built before the war. Both supply and exhaust outlets are made the same for giving the ceiling a pattern and harmony of design.

outlets, and interior outlets. One-half inch wire mesh is required over all openings to prevent the entrance of rats and the introduction of debris. Light-excluding features are essential in many cases.

Many of the *weather outlets* are similar to the simpler types used on land. The more elaborate ones are not used, since the heavier materials (at least ⅛ inch plate) required to withstand abuse and corrosion complicate the construction. If the opening is in a bulkhead, louvers or hoods are provided. Otherwise, cowls, goosenecks, or mushrooms are used. Mushroom, gooseneck, and cowl ventilators are usually fitted with manual fire dampers. Mushrooms and goosenecks require watertight closing devices when located where "heavy" water may reach them.

Cowl ventilators act as wind scoops, and are used for natural ventilation only. This type of terminal is made portable so that it can be removed in very bad weather. The ventilator is designed to slip over a watertight coaming (pipe) which is welded to the deck. A wood plug and canvas cover, or steel watertight cover is fitted over the top of the coaming when the cowl is removed. Cowls are in most cases made of No. 16 U.S.S. gauge steel for small sizes and No. 14 U.S.S. gauge steel for larger sizes. They are hot-dipped galvanized after fabrication.

The *interior outlets* are similar to those used on land, except that moving parts are more ruggedly constructed. In holds, storerooms, and similar spaces, an open-end duct or a cut in the side of the duct is satisfactory. If the velocity is high, expanding cones are used to reduce the entrance or discharge loss.

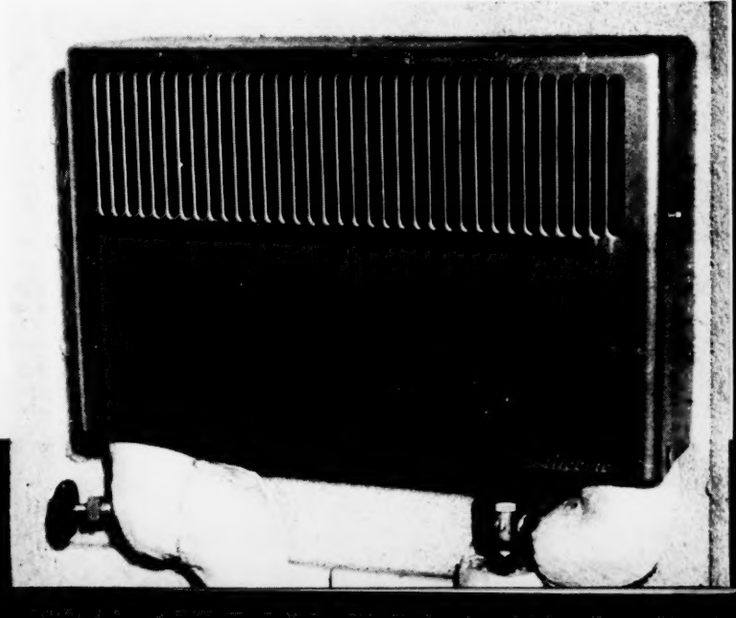
One-half wire mesh is used for exhaust outlets except in certain spaces where appearance is considered important. Here grilles, usually of the bar type (spacing ⅜ inch to suit rat-proofing requirements) are used. Frequently, shipyards find it more economical to purchase grilles (½ inch wire mesh or bar type). In some cases, it has been found advantageous to purchase exhaust grilles with key operated multi-louvered dampers. Balancing is simplified and the necessity for separate balancing dampers (butterfly, splitter, squeeze, etc.), is eliminated.

Hoods are provided in galleys, pantries, and shops, where large quantities of heat are liberated. These are usually made as simple as possible in order to facilitate cleaning. Grease filters are provided for range and fry kettle hoods.

Grilles, registers, and diffusers must be sturdily constructed to prevent rattling, normal abuse of service, and corrosion. Except for spun steel parts, gauges less than No. 20 gauge are seldom used. Parts must be galvanized, cadmium plated, or Bonderized, and painted. Special paints must be used to counteract the corrosive effects of salt air. Parts subject to wear must be made of corrosion-resisting material. Use of aluminum and stainless steel is prohibited at present.

Registers and diffusers are used in living quarters, office spaces, dining rooms, and similar spaces. Registers are of the wall type and are fitted with adjustable vertical face bars (stream-lined in most cases) and multi-louver dampers. The damper is face operated on registers located in small spaces heated by zone systems. This damper may be used to either throttle or direct the air vertically. Regis-

Fig. 40. Close-up of a Modine convector in an officers' bathroom.



ters for large spaces having individual heaters are usually fitted with key-operated back louvers, which are used only to control the direction of the air. The registers are usually sized for about 750 fpm nominal duct velocity, based on maximum fan delivery. It should be noted that this results in about 375 fpm nominal duct velocity with 50% speed reduction during the heating cycle.

Diffusers are constructed of a number of concentric spun cones, the outer cone being designed with an anti-streaking ring. Rugged construction is essential so as to prevent the operator from pulling the unit apart if the damper sticks—a not uncommon occurrence, for careless painting frequently impairs damper operation. The diffusers are usually sized for 1200 to 1800 fpm velocity at the neck or outlet, depending on which is the larger. Outlet areas are not less than 75% of the neck area. Diffusers are furnished with dampers where control of the air volume by the occupant of the space is required. Integral dampers are not considered desirable, as they complicate the diffuser installation and may be a source of noise, since they are located at a point where the velocity is high. A separate damper located in the branch supplying the diffuser is preferred. Integral dampers are designed to throttle the air by restricting flow at the connection of the branch to diffuser neck. These dampers have been poorly designed in some cases, and this has resulted in awkward operation, rattling, and abuse to the diffuser proper. However, in many cases ducts are ceiled in, and under these circumstances use of integral dampers simplifies the joiner's work.

Directional terminals are used in working spaces where spot cooling is required. These terminals are sized for 1500 fpm to 2500 fpm neck velocity, depending on the particular application. Construction must be such that adjustability is not impaired by painting.

Slotted outlets are also used where spot cooling is desired, but only where the air must not blow on equipment and diffuse the heat. The outlets are often found on the working side of galley hoods and switchboards. Slotted outlets are usually located on the bottom of the duct so that the air blows down. They are sized for 600 to 1000 fpm outlet velocity, depending on the headroom available.

Ducts. Ducts are constructed of considerably heavier gauges than are commonly found on land. Vibration, flexing of the vessel, and corrosion justify this practice. Ducts are usually rectangular, round ducts being used only for the smaller sizes. Cuts through structural members are commonly made round or flat oval for strength reasons. The following schedule is common for galvanized sheet metal work, the dimensions shown being the diameter for round duct or the longest side for rectangular ducts.

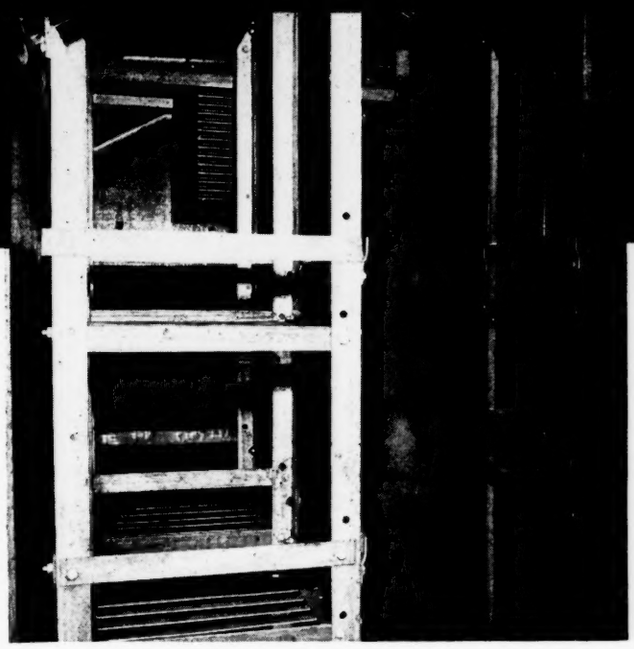
All vertical exposed ducts—No. 16 U.S.S. Ga.

Horizontal or concealed vertical ducts 24 in. and over—No. 16 U.S.S. Ga.

Horizontal or concealed vertical ducts, 18 in. - 24 in.—No. 18 U.S.S. Ga.

Fig. 41. This application of Johns-Manville BX-4M insulation is essential to retard the flow of heat from the engine room to an adjoining fan room.

Fig. 42. A view on the deck near the bow showing the gooseneck exhaust from the boatswain stores, paint room, and lamp room.



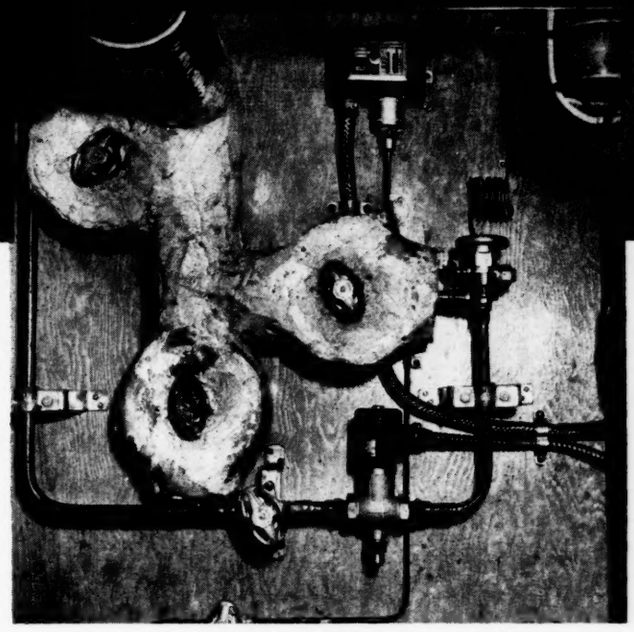


Fig. 43. (Left) York cold diffuser in the ship's stores vegetable room. Fig. 44. (Right) Controls for refrigerated cargo space including a Detroit cut-off, Alco Thermo valve, and York solenoid valve.

Horizontal or concealed vertical ducts, 12 in. - 18 in. — No. 20 U.S.S. Ga.

Horizontal or concealed vertical ducts, less than 12 in.— No. 22 U.S.S. Ga.

Ducts over 24 inches wide are fitted with external stiffening.

Large trunks are usually built-in, using adjacent decks, bulkheads, and similar structures for one or more sides. Ducts and trunks exposed to the weather are constructed of at least ⅛ inch plate and are made watertight. Built-in construction is not recommended where the area is less than 9 sq in. Handholes and access plate of adequate size must be provided to facilitate inspection, cleaning out, and painting.

Trunks and ducts in cargo spaces are made of ¼ inch plate when vertical and 3/16 inch plate when horizontal. These thicknesses are necessary to withstand the abuse accompanying cargo stowage.

Drive slips and similar connections are not considered suitable for ship work. Flange connections are recommended for joining section and all ducts must be made portable. A special type slip joint is employed where flange connections are impractical. Flanged spools or coamings are provided where ducts pierce decks, and similar connections are sometimes used at bulkheads. Where spools are not fitted on bulkheads, flanged connections are used.

The accompanying table of duct velocities reflects present practice, the velocities shown being higher than those formerly used in merchant vessel design so as to conserve material. All velocities are subject to modification to suit practical considerations, such as available static pressure, importance of noise, and space limitations. Velocities as high as 3500 fpm are allowable where noise is not important.

Volume, Cfm	Max. Velocity, Fpm
Up to 1,000	1,500
1,000-2,000	1,700
2,000-3,000	1,800
3,000-5,000	2,000
5,000-8,000	2,250
Above 8,000	2,500

Ducts are constructed with welded, riveted, or hooked seams. Hooked seams or spot welding is most common where gauges are No. 18 U.S.S. and lighter. Continuous arc welding is usually employed where gauges are No. 16 or heavier. Riveting is used only where the condition or equipment is not suitable for lock-seaming or welding.

Splitter, butterfly, or squeeze dampers are provided for balancing systems. Exhaust ducts from range and griddle hoods are fitted with fusible link dampers. Manual shut-off dampers are furnished to stop natural drafts when the system is not in operation.

Every effort is made to design elbows with a standard throat radius (throat radius equal to duct dimension in plane of bend), and concentric turning vanes are fitted where the throat radius is less than one-half the standard. Small radius turning vanes are used only where sharp compound bends occur, or where the duct terminates close to the elbow. Miter throat elbows with small radius turning vanes are used only where structural considerations prohibit the use of a throat radius. In general, turning vanes and baffles are avoided wherever possible. Not only are easy elbows efficient, but the cost and weight are less. In many instances, turning vanes shown on plans have been omitted in actual construction because of the pressure of work. Also, prefabricated ducts and elbows are frequently stored

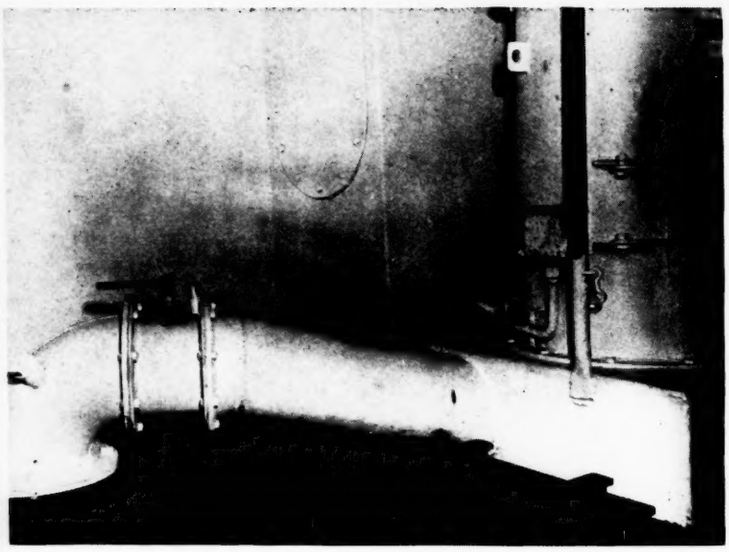


Fig. 45. Dry air supply pipe and shut-off damper, left center, and supply fan, right, which form part of the Cargocaire system.

in the open for many months before installation, and rough handling results in damage, particularly to vanes. Even where an effort is made to correct such damage before installation, little attention is paid to damaged vanes which a quick external inspection will not detect.

Many draftsmen, who are not familiar with general shipyard facilities, are reluctant to design trunks and ducts made of plate with easy elbows, because they consider such construction impractical. The truth of the matter is that duct work heavier than No. 12 U.S.S. gauge is usually handled by the plate and angle shop. This shop is equipped to roll and fabricate the steel plates just as easily as the sheet metal shop handles the lighter materials.

In accommodation spaces the main ducts are usually located in the passageways, and branches are provided for carrying the air to the staterooms and similar spaces. This practice improves the appearance of the staterooms as headroom is increased by the absence of large ducts. Ducts are frequently ceiled in so that only the outlet and damper are exposed.

Insulation. Mineral wool or spun glass are the most common for duct insulators. Corrugated asbestos is not recommended because the presence of moisture tends to disintegrate it. All insulating materials must be incombustible. Generally, semi-rigid insulation is used because it is simpler to install. Blanket type insulations are applied only to round or curved surfaces, and are secured with twine and lagged with canvas, sewed on. Semi-rigid type insulation, secured by adhesive, flat wire bands, and corner clips, is lagged with canvas only where exposed. The thermal conductivity of insulation must be not greater than 0.30. Blanket type insulation is at least 1 inch thick. The thickness of semi-rigid insulation is frequently based on the accompanying table.

Fans are not often insulated. Preheaters are frequently located close to the fresh air intake in order to conserve insulation, and for the same reason zone reheaters are located as close to the zone as possible. Where a reheater serves only one space, the heater is commonly located in the space.

Much discussion has taken place regarding the merits of insulation and the proper thickness required. Sea air generally contains much more moisture than land air and the corrosive effect is greater.

Fig. 46. Part of a deck fan room showing the 16-gage ductwork and welding. Note heavy coaming at deck.

TABLE 3.—INSULATION THICKNESSES

Application	Thickness, In.
Tempered air ducts in unheated spaces were a temperature differential greater than 35F exists	½
Cold air ducts, supply and exhaust passing through heated spaces	1
Exposed ducts in heated spaces, carrying reheated air	½
Concealed ducts carrying reheated air, adjacent structure exposed	1
Concealed ducts carrying reheated air, adjacent structure not exposed	½
Ducts serving only the space in which they are located	None
Exhaust ducts carrying hot gases (galley, forges, etc.) in living and working spaces	1
Supply ducts in machinery spaces and similar hot spaces, serving spaces other than the hot spaces through which they pass	1
Heaters	1
Ducts subject to excessive sweating	½

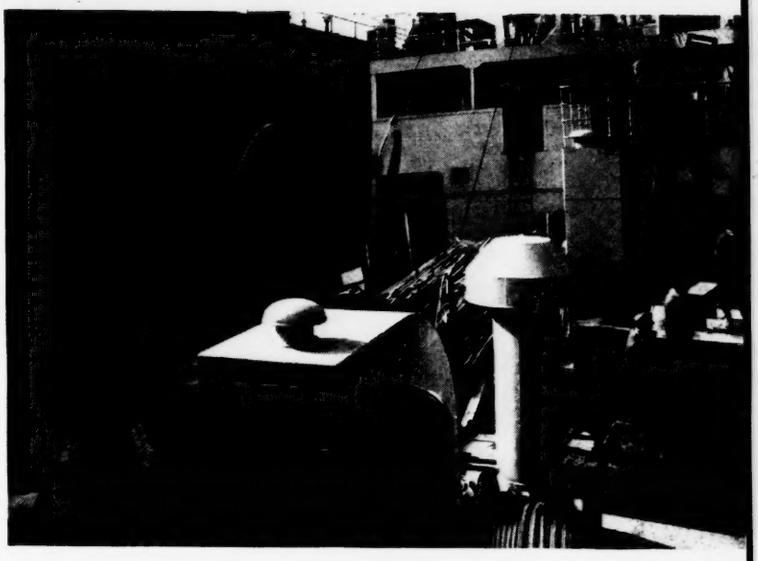
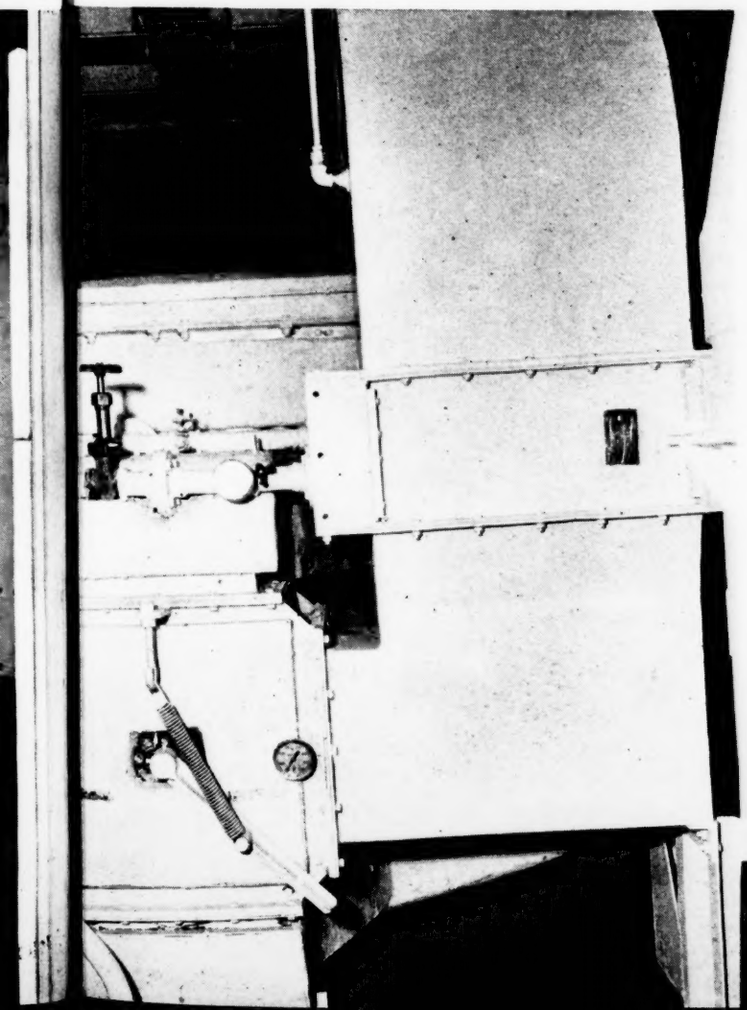


Fig. 48. An after-deck view, looking forward, showing two types of mushroom ventilators. The one in the foreground is on the booby hatch to the stairwell, while the cylindrical ventilator at the right is an exhaust from a shop.

Fig. 47. Four-way damper for the dehumidifying system with Young aftercooler coils shown in the center right.



Also, the runs of ducts are relatively long. This applies particularly to zone systems which are designed with the assumption that the same hot air temperature is available at each space. It is also true that where insulation is provided, the difference in cost of furnishing ¼ inch, ½ inch, or 1 inch insulation is relatively small, for the cost of labor and lagging is almost the same in each case. This, of course, is not true where very light insulation and lagging is provided to cover crude sheet metal work, nor does it apply where weight is an important factor.

Label Plates and Operating Instructions. Experience has proven that adequate label plates and operating instructions are essential if all the benefits of the systems and efficient operation are to be obtained. Many operating engineers are unfamiliar with the operation of combined heating and ventilation systems, and good operating instructions permit them to become familiar with the equipment in a very short time, thus eliminating the trial and error method of operation which would otherwise occur. Operating instructions tend to give an engineer more confidence in the operation of the equipment, particularly thermostatic controls and filters, and label plates, of course, facilitate identification and operation.

The fact should be strongly emphasized that the heating and ventilating equipment on the average

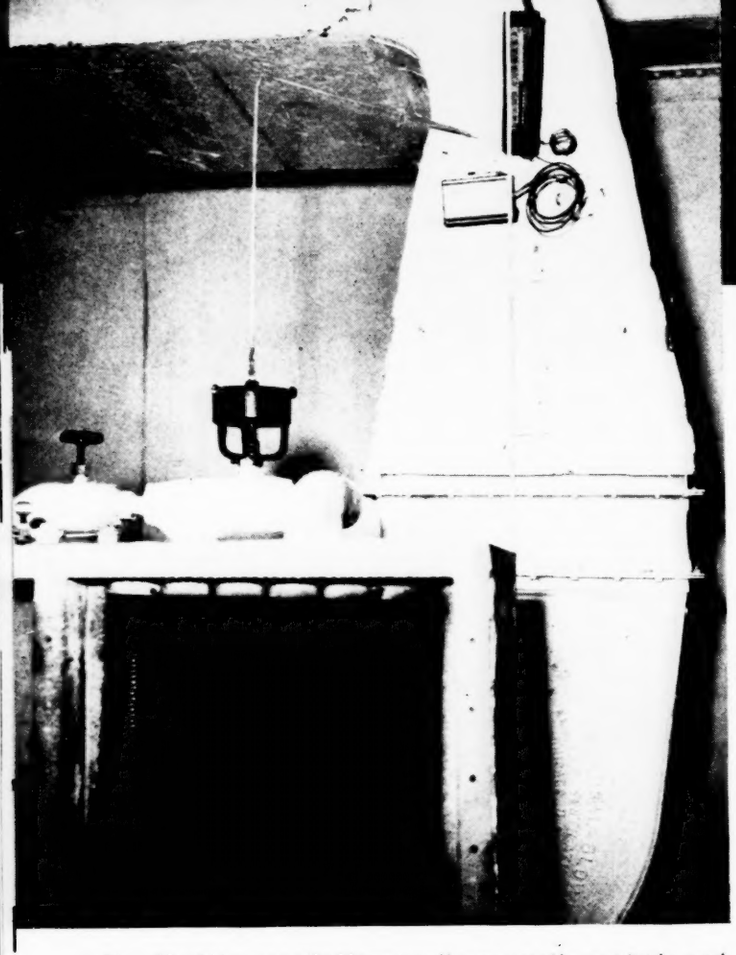


Fig. 49. Minneapolis-Honeywell pneumatic controls and thermometer for Aerofin non-freeze preheater of zone system on merchant vessel. The IIg fan shown has cast iron sides; however, sheet steel construction is preferred and more common. Note the by-pass at the left hand side of the heater casing.

ships is a relatively minor part of the ship's machinery. For this reason, the engineer cannot afford to spend an undue portion of his time becoming acquainted with these systems when he also must operate and service the main propulsion machinery and boilers, main auxiliaries, and other auxiliary equipment as well. Anything which is done to simplify the operation of the ventilation and heating equipment will help to insure the successful operation of these systems.

Label plates should be of the engraved or embossed type using brass, steel, or plastic material. The plates are used to identify each fan, heater, thermostat, damper, supply and exhaust outlet, and other major parts of the systems. Instruction label plates are provided for dampers and outlets on systems used for dual purposes, such as ventilating resistor spaces and holds with the same fan. Operating instructions covering the systems housed therein are posted under glass in each fan room. A master copy for all systems is provided for the chief engineer's office. These instructions should include a diagrammatic plan of the systems and special information for servicing the equipment.

Deviations from Land Practice

The foregoing has indicated many instances where ship ventilation and heating differs from land practice. It is apparent that space limitations generally result in relatively compact designs, smaller equipment, and higher velocities and steam pressures. Salt air and movement of the ship (internal and external) require unusual protection against corrosion and more rugged "rattle-free" construction. Variations in the trim (level) of the vessel necessitate unusual consideration of the drainage problem. Operating personnel is limited and transient so that simplicity and reliability are particularly essential. This is even more pertinent under present circumstances since supervision and inspection have become lax due to the rush of work which permits observation of only the most important factors. Noise is considered important only where it affects navigation, operation, or the efficiency of the operating personnel.

Under ordinary conditions, an effort is made to design systems on large vessels to suit the psychrometric conditions of the intended voyage. No effort is made to do this on cargo ships as they may operate anywhere in the world. Obviously, degree-days and prevailing winds cannot be considered under these circumstances. Today design data are even more universal, for any ship, no matter how large or small, may be required to operate in the tropics or near the poles and the ventilation and heating systems must therefore be reasonably adequate for all demands.

Probably the most serious criticism of ship ventilation and heating is the lack of adequate tests. Some of the criticism is justifiable, and some is not. To test equipment properly it should be operated without interruption under conditions approaching those for which the system is designed. In addition, personnel trained for this work, familiar with both the systems and the instruments, must be available for performing the tests. Such ideal conditions rarely exist in shipyards. Even under normal conditions, little if any time exists between the completion of the system and the vessel's departure from the shipyard. As a result, interruptions of all kinds accompany testing; adverse wind conditions make reading of the instruments difficult; frequently outlets are inaccessible so that much recording must be done working on ladders at high elevations; power interruptions are frequent and spaces are congested with both equipment and workers. Further, tests are made by test crews which, in many cases, handle the testing of all equipment on the vessel and therefore do not have time to acquire the special technique required for air flow measurements. Instruments are seldom cali-

brated and often misapplied, and in very few cases are observers well informed regarding recent research and improvements applying to the instruments used. In many instances the ship has sailed before the tests are analyzed to determine the condition of the systems. Frequently, when unsatisfactory operation is reported, the test and service reports are not adequate for a complete analysis of the situation, so that constructive criticism cannot be made.

Future Development

The United States Merchant Marine will face greater competition in the future than ever before. Ships of other nations as well as planes will be competing for trade and traffic. Air competition can be dealt with only by emphasizing those features which air transportation cannot afford, i.e. better personal service and comfort, entertainment, spaciousness, lower cost, tourist activity, and safety. Foreign marine competition can only be met by providing more luxurious service for the passenger trade, and faster speed and facilities for serving the cargo trade. Efficient operation will naturally be essential for economic reasons.

Preservation of dry and refrigerated cargoes will play an important part. New methods, or improvements of present methods, are bound to occur. Underwriters and shippers are becoming aware of the fact that certain cargo damage previously considered an act of God can be avoided. These organizations will demand that proper precautions be taken to protect their interests.

Comfort is one of the essential requirements of successful passenger trade, and it therefore follows that American designers will take advantage of the advancement made in the air conditioning field to encourage this trade. The policy of air conditioning all passenger accommodations is not new, as the design of at least two large vessels incorporated this refinement. It should be noted that all passenger vessels built in this country within the last five years have air conditioned dining saloons, and it may easily be anticipated that most new designs will provide air conditioning for all passenger accommodations. Such a policy will require the development of special methods and equipment for this application, and skilled personnel will be required successfully to operate and service the systems. Also, more economical methods will be required to achieve the desired results. At present comfort cooling is accomplished by direct expansion systems using Freon 12 for the refrigerant. The increase in refrigeration tonnage for this application on future vessels may possibly cause the adoption of steam jet refrigeration, as on ships there is virtually no limit to the quantity of cooling water and supply of high pressure steam.

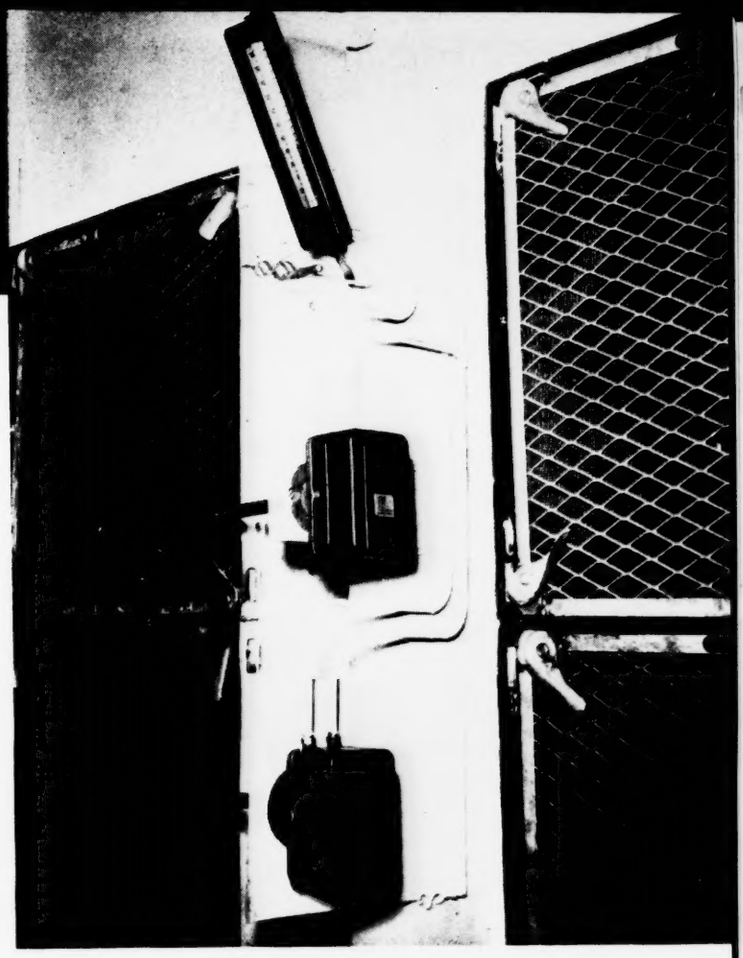


Fig. 50. View on a Maritime Commission vessel, showing American washable, viscous, marine-type filters, master bulbs for Minneapolis-Honeywell pneumatic system controlling zone reheaters, and thermometers.

The future will probably bring considerable study of the noise elimination problem. These studies have been retarded for the present. Such improvements will not only affect air conditioning equipment but all other noise sources, such as machinery spaces, sanitary piping, and public spaces.

Ships will be much faster. Where today 25 or 30 knots (1 knot = 1.15 mph.) is maintained, 40 and 50 knots may be common in the future. Smoke elimination, already a problem on many ships, will be even more important. It should be noted that this problem has been aggravated by the tendency to shorten stacks for stream-lining effect.

From the above it may be seen that both comfort and industrial air conditioning will play an important part in the future success of the United States Merchant Marine. The cooperation and assistance of the air conditioning industry will be required if our Merchant Marine is to attain its objectives.

Air Conditioned Room Used for Refrigeration Life Tests

By H. K. SELLICK

Philco Corp., Engineering Division, Philadelphia, Penna.

Although refrigerator manufacture was discontinued many months ago, it is interesting to note that life tests begun on models before the ban was applied are, at least by one manufacturer, still in progress. This article describes the purposes of these tests and the methods used, and shows how the air conditioned test room plays a featured part.

THE study of changes and improvements in design of all types of household appliances is a factor seriously considered by the manufacturer. An advanced step in the study of changes and their incorporation in contemplated and current design refrigerators has been taken by the Philco Corporation, by means of an air conditioned room used for Life Test work. The air conditioned room is laid out to contain a total of sixty refrigerators, all of which may be operated at one time. Branch circuits are individually fused as each branch power supply is connected through a fused disconnect switch for protection and convenience.

The room was built near the assembly lines to permit models to be selected at random as desired for check-up on the general run of production, as well as the advance models that require testing and detailed observation over a period of time.

Due to the many changes normally involved between the time that a design is accepted by the management and when tooling is completed and production actually started, a specific check-up is essential. Certain specifications are originally set-up and it is essential to know whether or not such requirements are maintained up to the beginning of production and during subsequent production runs on each model.

In this article the writer will endeavor to outline the equipment, procedure and tests used for the operation of the Life Test Room.

Description of Room

The complete Life Test Room is approximately 131 ft long by 36 ft wide and has sufficient capacity to operate 200 refrigerators at one time. It is located within a heavy walled brick building which provides ample insulation for the application. Twenty refrigerators are placed on one circuit, with each of the circuits individually wired and protected. The room itself is then divided into two sections—one having normal atmospheric conditions, and the second, with a capacity of sixty refrigerators having the air conditioner installed. All exposed walls and the ceiling are covered with suitable wall board and each window is fitted with storm sash. As the humidity section is entirely sealed and segregated

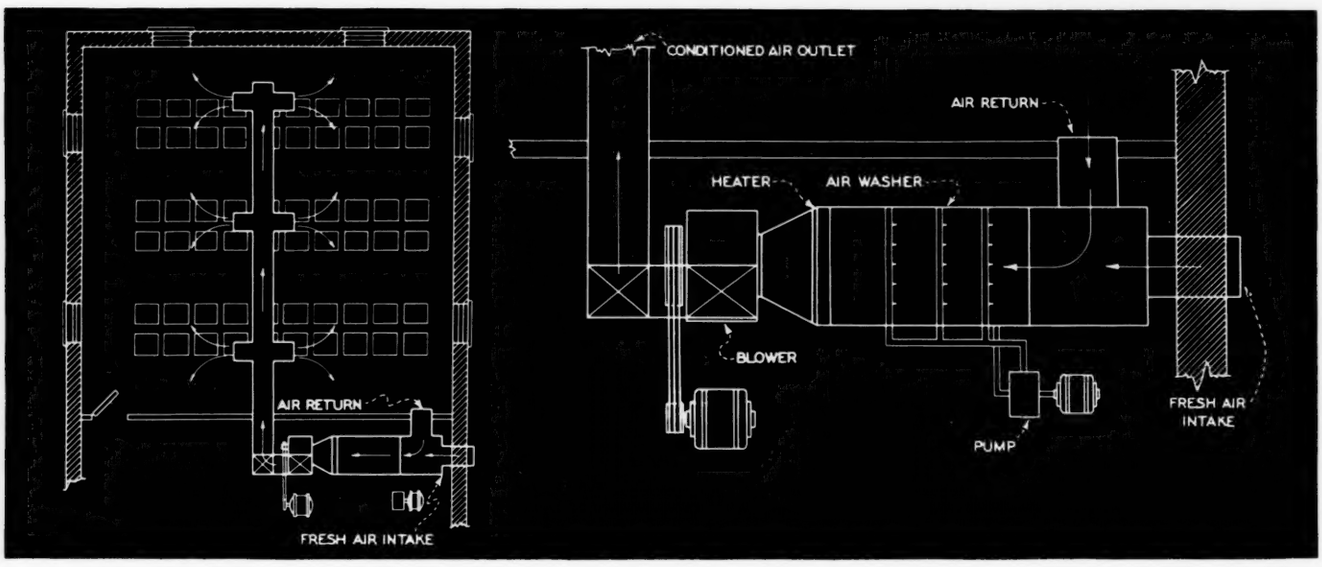


Fig. 1. (Left) Schematic layout of test room showing arrangement of air conditioning equipment and ducts. (Right) Detail of the air washing and heating unit. Steam is used for heating and humidifying except during spring and fall when the same operations are performed electrically.

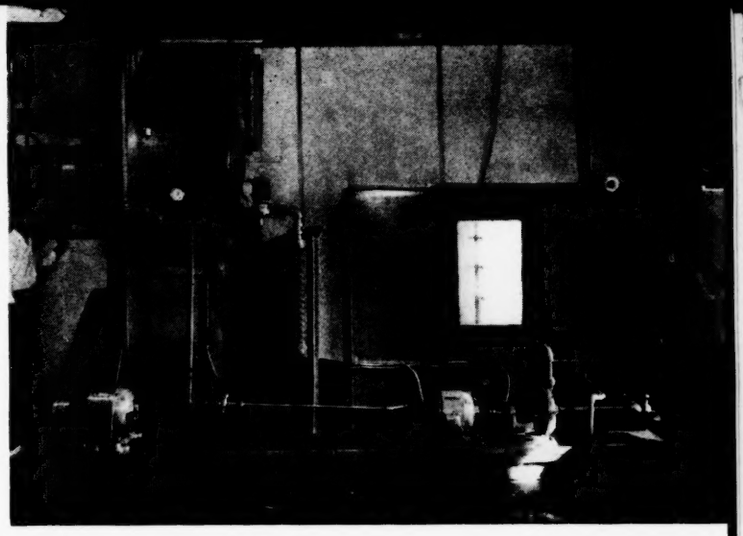


Fig. 2. View of air conditioner consisting of spray washing and humidifying chamber, reheaters and fan.

from the rest of the room, the temperature and humidity are maintained by the conditioning and circulation of the air within the room or intermixed with outside air as required.

Air Conditioning Equipment

A schematic layout of the room is shown by Fig. 1. The equipment was installed by Drying Systems, Incorporated, of Chicago, and so designed that conditions varying from 85F and 75% relative humidity to 95F and 65% humidity can be maintained. Additional facilities are available for tests requiring greater humidity, but are not considered in this article. The conditioning unit is so designed as to normally operate by recirculating the air in the room. The recirculation duct vanes, however, are mechanically interlocked with the fresh air vanes from the outside, so that fresh outside air is automatically admitted as required.

In designing this system, the heating coils were made dual-automatic for either steam or electric operation, as the room is so situated that steam is available during cold weather only. The change from steam to electric operation is made by throwing a steam-electric switch which automatically changes over the heating source. Referring to Fig. 1, (right) the water spray is supplied by a series of spaced nozzles, and is maintained by a motor driven pump, which continually recirculates the water in the system. The water level in the spray chamber basin is maintained by a float regulator which admits hydrant water as needed. The water supplied to the sprays is heated either electrically or by steam as required, with the temperature controlled by the wet bulb thermostat.

The air is returned from the room and passed through the water sprays, then through the heating coils and the fan, and forced out through the ceiling ducts and distributed throughout the room. Exploration thermometers show the temperature at various points of the room to be held within $\pm$ 1½F.

Control of the air is maintained by means of individual wet and dry bulb thermostats which, when properly set, maintain the correct predetermined conditions within the room. The wet and dry bulbs are located within the return air duct between the room and conditioning unit. Fig. 2 shows the air conditioner in operation and Fig. 3 shows the interior of the room with the ceiling ducts and the conditioner intake from the room in the background.

Purpose of Tests

The careful study, over an extended period of time, of a number of refrigerators when operated under adverse conditions will bring to light many points that otherwise might be overlooked, or uncorrected until such time as field complaints begin to come in. By maintaining the adjacent test room operating under normal conditions, a direct comparison of results may be made and the comparative performance of the refrigerator under normal conditions as well as under abnormal conditions thus determined.

In constant surveillance of all tests is a specially trained member of the Engineering Department, who has had the experience of field work in southern territories providing a knowledge of the difficulties of sweating, leakage, warpage and the multitude of other hazards with which the heating, ventilating, and refrigerating field is familiar.

For preliminary work, sample models made in advance of final approved designs may be thoroughly tested and the final production design released with assurance. In addition, due to the capacity of the test facilities, the tests may then be continued over an extended period of time and direct comparison made with the actual production refrigerators.

Refrigerators from first production, as well as subsequent production runs, are selected at random to be placed on test. Each refrigerator is completely assembled with all equipment in place ready to install in the user's home. Then each is carefully

Fig. 3. Interior of test room showing arrangement of refrigerators under test. Air at the proper temperature and humidity is supplied through the ductwork and diffusers overhead.

checked for any defects that may have been overlooked in quantity production. Such defects are immediately corrected on the assembly line instead of waiting for complaints to filter back from the field, possibly some months later. Each unit is then checked for such information as evaporator temperature, frostback point, and other information considered essential and of possible importance at some future time during the test period.

Test Procedure

A brief outline of the principal points checked is as follows:

1. With the control set in the *normal* operating position, the unit is checked for noise which could be caused by vibration, improperly located tubes, loose grommets, or any unusual condition.

2. Door seal is checked by means of a standardized test. Different methods are used by various manufacturers, but it is essential that the same method be followed throughout the observation period for obvious reasons.

3. At any sign of condensation or leakage, the job in question is immediately torn down to isolate the trouble and to make whatever correction is required.

4. Color match of both exterior and interior parts is noted and any deviation of discrepancy recorded for future reference.

5. The exact position or location of frostback is recorded after a sufficient length of running time has elapsed to definitely establish such a point.

6. The refrigerator temperature, per cent of running time, and kilowatt-hour consumption per 24 hours, are determined.

7. Each day during the test period, the food compartment door is opened and closed for three periods of one hour each to simulate door opening under normal use. Present practice is to open the door for one minute, then to close it for the following five minutes. This gives a total of 10 openings during the hour, representing one meal period in the home.

8. After observing the operation of the refrigerators for a short time while set in the *normal* temperature zone, some of the controls are moved to coldest position and some set to operate continuously for further observation.

Systematic check-ups are made and recorded in all instances and each of the items mentioned is carefully watched for failure, breakdown or deterioration, as the case may be. Periodic observations are made for breakdown or distortion of internal as well as external parts, plastic parts and accessories, including the collapsing of door gasket or other parts of similar construction.

Summary

1. The use of the air conditioned life test room with its close temperature and humidity control provides means for making a first-hand study of the apparatus operating under field conditions over an extended period of time.

2. Direct comparisons may be made using similar refrigerators operating at different temperatures and in different ways with the same atmospheric conditions.

3. On production models, field troubles may be isolated and corrected before large quantities are built and shipped to the field.

4. Results are obtained in quantities sufficiently large to permit safe conclusions to be made, thus eliminating the necessity of making a decision based on a limited number of tests.

In general, the results obtained are beneficial to the Engineering, Production and Inspection Departments, to such an extent, that the expense involved in equipping and maintaining an air conditioned room for life tests is considered well worth while.

Marine Propulsion Gears

are hobbed in individual constant temperature and humidity rooms using 25 air conditioning units of small capacity.

With the tightening of critical materials, many new plants are, of necessity, air conditioning only certain vital areas instead of the entire plant, using small scattered air conditioning units for essential production spots.

A typical case of this spot air conditioning is in holding constant temperature and humidity while cutting marine propulsion gears. At one plant, each of the precision hobbing machines are in separate insulated rooms and air conditioned by 25 units ranging from 2½ to 5 tons.

Holding constant temperature throughout the continuous 17-day gear cutting period maintains the close tolerances. Similarly, low relative humidity prevents condensation on the gear and tools. From two to four men work in each room and outside air is introduced, mixed with room air and brought through the air handling unit to provide a proper working atmosphere. The internal design conditions are 75F dry bulb, held within ± 1F, and the relative humidity is held at approximately 60%.

The rooms vary from 12 ft x 12 ft x 16 ft high to 38 ft x 32 ft x 18 ft high and are of double steel construction with insulation between the walls. Each air conditioning unit has a heating and cooling coil; 13 evaporative condensers are used for condensing purposes.—*L. W. Clifford, Supervisor Sales Department Section, Westinghouse Electric and Mfg. Co.*

WARTIME DESIGN RESTRICTIONS FOR CONSERVATION

HEATING AND VENTILATING'S REFERENCE SECTION

9

HOW TO MEET WAR TIME RESTRICTIONS

BY T. W. REYNOLDS

EDITOR'S NOTE: Today it is necessary for design engineers to think primarily in terms of weight of critical materials used. Consequently, this reference section is presented to suggest ways in which heating, ventilating and air conditioning systems can be and are being designed so as to accomplish their purpose but at the same time be so built as to employ the minimum weight of critical materials.

The reader is asked to keep in mind the following points:

(1) So as to avoid the endless exceptions, modifications, and technical limitations which make specifications and directives dry and practically unreadable, the author has made numerous flat statements which are believed to be true in the majority of cases but not necessarily applicable to every last job.

(2) Since this document has been so prepared, it makes no claim to being official or even quasi-official. However, the suggestions it contains are those of the author who has had considerable experience in conservation of critical materials in connection with heating, ventilating and air conditioning, and consequently these suggestions are believed to be reliable and practicable.

(3) Throughout this section comparative statements regarding equipments, materials, systems and methods frequently appear. Those which are favored are so rated primarily from the standpoint of all-over weight-of-metal only; where necessary, however, the author has supported conclusions made with this objective by giving other advantages of favored products. These comparative statements seem justified by the importance of the emergency, but obviously some may not have been valid before or may not be valid after the present need for conservation.

Ingenuity and skill must today be exerted so that designs and specifications conserve critical materials[1]. For the duration of the present war, it should be possible at not too great a sacrifice in convenience, efficiency, professional pride, and appearance materially to reduce our consumption of strategic and critical materials.

With the objective of attaining such conservation, the information which follows on present day conservation methods has been assembled for the use of the engineer and architect in preparing drawings and specifications on mechanical equipment of buildings. While not all may agree with all of the practices outlined, many installations are being designed along these lines, subject to variations as thinking changes with time and relative scarcities of materials.

General

When designing and estimating the engineer and architect should eliminate or reduce factors of safety in capacity of equipment, and instead use the nearest smaller size of pipe, pump, or motor. This particularly applies so to unit heaters, whose commercial sizes are usually well above the calculated requirements.

The design should be gone over for possible relocations of certain spaces or departments which, without detriment to production could be located at some other point which would involve use of less critical materials. For example, where possible, the boiler plant should be located for central distribution and close to roads, yet convenient for a minimum in requirements for coal and ash-handling equipment. Windows increase the heating load and should not be larger than necessary because of architectural considerations such as matching up the windows in the adjacent structure, nor should a wall be left blank on each side of an exterior door when this may create a condition which requires ventilation of the blacked-out rooms with consequent unnecessary use of copper for ventilating motors.

The design should be stripped to that method requiring the least weight of critical material; then the method itself should be stripped so as to use the least weight of critical material entering into that method. Furthermore, design and estimating should be co-ordinated with procurement so that when there is difficulty in purchasing an item some alternate could be substituted so as to avoid any further delay in construction. Material estimates should also be carefully made up, since any excess material, even though eventually used on some other project which the owner intends to build within a few months, is in effect hoarding of materials and may delay other projects necessary to production.

It is desirable that the architect and engineer co-operate each with the other so that the overall weight of the structure and its mechanical services will be one which embodies the least weight of critical materials. For example, one type of heating systems may have less weight than some other type, but may require a greater weight of critical materials in the structure itself.

Where land is available and floor loadings are not excessive a one-story building is preferable to a multi-story structure so as to conserve on steel. For example, a four-story building 100 x 40 ft in plan and 40 ft high might well be re-designed to a one story building 400 x 40 ft in plan and 10 ft high. The saving in structural steel obtained must be balanced against the increased weight of the heating system, for the one-story structure might require 67% more radiator weight, three times as much weight in heating mains, or approximately eight tons more of metal than the multi-story structure. This illustrates the need for the co-operation between the engineer and the architect.

If the project under consideration has related projects which may follow shortly, these should be brought into the picture to the extent that the overall method of design is weighed now, so that the future projects will not be handicapped by present decisions. Without such study it is quite possible that a design solely for the immediate needs might be selected which though presently economical in critical materials would not be so for the projects as a whole.

Although essential construction must proceed without delay and critical materials must be conserved neither should be done at the expense of the other. For example, a plant substituting non-critical materials for the production of war equipment now made of critical materials would, when completed, save more critical materials in one day than could be conserved by delaying the start of production one week while search is made for second hand equipment.

Upon occasion an owner must spend more money when non-critical materials are substituted, but the additional cost should be spent. Comfort and convenience should be subordinated to war needs, providing there is no undue hardship. On the

[1] A material is "critical" when it is no longer available in the quantity required for the war effort and essential civilian needs.

other hand, in many cases money has been saved for the owner, better ways of doing the job have come about, and the engineer has become acquainted with the use of desirable substitute materials which in the ordinary course of events would not have been adopted for a long time simply because of the usual lapse of time between the introduction of new material and its general acceptance.

One may be puzzled as to why certain material is restricted when he knows there is plenty available in his particular locality; what he does not always appreciate is that it does not take long for the stock-pile to dwindle when manufacture of the material has been stopped, nor does he realize that a local excess may soon be needed to cover a deficiency elsewhere. Equipment and material, whether second hand, currently frozen, idle, or in excess amounts is now being located and transferred to war production. For example, only a few months back plenty of wood was available, so that it was freely used in construction as a substitute for metal; the nation's stock-pile soon became exhausted, and as a result certain kinds and sizes of wood are currently critical.

Occasionally materials are required to replace a heating system which has been wholly or partly destroyed. Such a loss does not necessarily entitle an owner to modernization of the plant or even to the same materials as those destroyed, since all construction is considered today solely on the basis of its essentiality to the war, and then only so as to last for the duration.

CONSERVATION VS. CODES

In some instances the engineer should recommend action on the part of the owner which conflicts with insurance requirements or with local and State codes pertaining to plumbing materials, fireproof construction, elimination of metal fire stairs, elimination of fire escapes except on the outside of buildings more than two stories high, sprinkler systems, elimination of ventilation, smoke ordinances, use of various materials, or the use of war time emergency stresses for steel. In such cases the engineer may request code administrators temporarily to relax their requirements, basing his request on material scarcities. Code and regulation administrators have responded to such requests with whole hearted co-operation in most cases and have usually given their approval with the reservation that non-conformance is approved for the duration only. In many such cases corrections will never be required as the buildings will ultimately be abandoned; where they are not the changes to bring about compliance will ordinarily be of a nature not too costly and will serve to provide useful work after the war.

Equipment which is proposed merely for standby, emergency, or other form of insurance may often be eliminated when analysed in accordance with war time needs. For example, in many cases the weight of pipe and bronze sprinkler heats entering into a sprinkler system may be so great that it is desirable to chance the fire hazard. Of course, war plants under 24-hour operation are a greater risk due to the longer hours of operation, but on the other hand in these plants there is a much greater chance of the fire being observed before it has spread to any degree. Quite often only a fire hydrant system is all that is required as such systems protect the plant against complete destruction and do this with less critical materials than in the case of sprinkler systems. Fire hose in such cases should be limited to 1½ inch canvas equipped with ferrous metal nozzles and couplings without metallic coating.

ESSENTIALITY OF PROJECT

The necessity for all proposed construction work should be analysed in accordance with the following principles:

(a) The construction must be essential to the war effort and any postponement would be detrimental to that effort.

(b) In general, the construction should be of the cheapest temporary character with structural stability just sufficient to meet the needs of the service which the structure is intended to fulfill during the period of its contemplated war use, the guiding principle being always **to utilize those materials which are most plentiful** and which is the ultimate analysis, will cause the least interference with the production of combat material and with the utilization of transportation and power.

(c) It is not practicable to rent or easily convert some existing facilities for the purpose in mind. For example, when a building is rented for the usual purpose of expanding facilities for production as required by additional war orders, the owner should attempt to obtain a building (1) with adequate heating equipment already installed, or (2) which can be supplied with steam by a utility, or (3) supplied with steam from an adjacent plant.

(d) It is not possible to increase productiveness of present facilities by working additional shifts or other means.

(e) The construction will not result in duplication or unnecessary expansion of existing plants or facilities now under construction or about to be constructed.

(f) If it is necessary to move the plant the existing heating, ventilating, and process equipment will be moved and re-used.

(g) All non-essential items have been deleted, the overall design is of extreme simplicity and will require the least weight of critical material.

(h) Consideration should be given where structures are of small size to determine if a stove or stoves can provide sufficient heat.

(i) There will be labor, materials, and equipment sufficient both to build and operate the project without delay and this without attracting labor from more essential war production.

(j) There are or will be adequate housing and other community facilities, public utilities without costly extensions, and sufficient transportation facilities for labor and materials.

(k) Finally, consider whether if the proposed project will not meet the foregoing requirements, there will be exceptional hardships imposed upon the owner, and also the effect upon employment.

GLASS AREA REDUCTION

Serious thought should be given to reducing as far as possible the glass area of industrial plants so that the weight of metal in heating and air conditioning[1] systems may be reduced. Most war plants do not depend upon windows for lighting as they usually have sufficient artificial lighting because of night operation.

If a building has been acquired with skylights or windows of greater area than necessary glass should at least be partially blocked off to conserve on heating; where air conditioning systems are to be installed for manufacturing processes the glass may well be completely boarded or bricked up in the air conditioned sections.

Substantial savings in a number of cases have been made where these methods have been carried out, particularly so where old plants have been acquired which were formerly heated only for storage and warehouse purposes or were adequately heated for the processes of those days, but which are not properly heated for present operations. In such type of buildings it is frequently found that closing off of glass together with application of a certain amount of insulation may make unnecessary proposed new heating facilities.

In the case of newly-constructed buildings the glass area should never exceed twenty per cent of the floor area; in fact the glass area should be reduced as far as possible below this percentage as is consistent with ventilation and natural light, but without increase in artificial light to the point where the copper requirements are excessive.

[1]Air conditioning may only be used in these times where manufacturing processes make its use essential and not for comfort or to increase efficiency of personnel. Ventilation is allowed in blackout buildings.

INSIDE TEMPERATURES

Material can be conserved in heating systems by carrying lower temperatures than 70F as in toilets, locker rooms, wash rooms and stair halls, by omitting heat entirely wherever possible in enclosed passageways between buildings, and by eliminating humidification, except as required by the process. In storage buildings and warehouses the prevailing temperatures can usually be low; where such buildings are heated only because they require a wet sprinkler system there is an added reason for eliminating the sprinklers from the project. Certainly it is a mistake to heat an entire warehouse, as sometimes proposed, merely because it contains a few workers who might be grouped in a space which could be partitioned off and heated, or who could be made comfortable enough simply by means of spot or local heating.

High standards for workers' comfort and introduction of women into industrial plants may in many cases prevent any lowering of temperatures, especially where the women are lightly dressed, do light work while seated at benches and therefore cannot tolerate lower temperatures. In addition, women workers must have adequate rest rooms, and perhaps their employment may mean rearrangement or additional toilet, wash room and locker room facilities, all of which require critical materials. Plants which do not provide these may be unable to compete with other plants for labor.

If in some cases temperatures cannot be lowered, they can at least be prevented from going too high. In normal times overheating means only a waste of fuel, but in wartime overheating may indicate that metal has been used where it would not have been had various heat gains been taken into account. Heat loss computations should be reduced by subtracting the quantity of heat given off by heating pipes and warm air ducts purposely left bare of covering†, covered process piping, hot process exhaust ducts, lighting, the occupants, and high motor loads.

Heat loss so calculated, together with reductions from building insulation and the omission of pipe covering, often show that it is unnecessary to increase the boiler capacity even though the heated space has been considerably enlarged for plant expansion. For example, in one plant there was no time or space left for hot forgings to cool off, so that they were delivered to another department with such a quantity of heat stored in their mass that power-driven ventilators had to be installed for heat removal.

†But not to the extent that working conditions become unbearable on mild days which is seldom the case in large industrial plants, and even where this should become true, covering can be applied when and where found needed.

So much heat is given up in various ways within some buildings that it is a question whether temporary buildings (which is what war plants really are) should have any heating systems whenever they are located in mild climates, where heat lag and heat gains are sufficient for occasional drops in outdoor temperature.

In alteration work overhead piping made useless by the changes should remain connected for the heat it contributes unless it can be re-used; otherwise it has value only as scrap, for which labor and transportation would be required.

PIPING

Piping should be sized for minimum size by designing with a substantial pressure drop. In the case of high-pressure steam systems the drop should be all that will be borne; in the case of low-pressure steam heating system the drop should be on the basis of one pound or at least one half pound pressure drop per one hundred feet of run. Where exhaust steam from drop hammers is utilized for heating and the back pressure on the hammers must be kept within limitations it is still possible to save considerable metal in piping by sizing the usual long run of the exhaust heating main on a low pressure drop and the balance of the distribution heating system for a high pressure drop.

Mains should be routed directly. Second-hand piping can often be used, even if of larger size than that required, particularly where pressure drop is limited. Quite often a central distributing main with long small size branches will make for more linear feet of pipe but will save on weight. Piping run in basements is preferable to that in first floor ceiling construction as it will eliminate the drops to radiators otherwise required, but where distributing pipes can be used to heat the space they should be run at the ceiling. A particular design of piping system should be selected only after careful study as to the least weight of piping, though, except where second-hand pipe intended for scrap is used.

Standard weight pipe and fittings should be used at pressures well above what have been used for design; where extra-strong pipe is really required, it is especially desirable to use second hand pipe. Hydraulic test pressure for standard weight pipe is 700 lb and bursting pressure from 1200 to 3000 lb, so that a factor of safety of, say, three times the test pressure should be sufficient for the use of pipe in wartime.

Flanged fittings, except for header assemblies should be avoided wherever possible. A 6 in. screwed all and tee weigh 30 lb and 41 lb, respectively, but the same fittings and sizes when flanged weigh 75 lb and 105 lb. In the case of valves of the larger sizes it is more desirable on the job that these be flanged and in any event the difference in weight is negligible; thus a 6 in. outside screw and yoke valve will weigh 150 lb when screwed and 175 lb when flanged.

Copper expansion joints should be eliminated in the basic design wherever possible; instead, use swing joints at all branches and connections, and eliminate long expansion loops which use more metal than do expansion joints. The latter are sometimes obtainable with steel sleeves, but no type of expansion joint is obtainable with quick delivery.

Ceiling, wall and floor plates and sleeves for pipes can be eliminated except when made of non-critical materials.

A discussion on piping would not be complete considering its covering and the confusion which exists regarding its use when made of 85% magnesia. Fibers which make up the magnesia were formerly critical because the use of longer fibers necessitated transportation from South Africa, but this is no longer true, as it is now brought from Canada. Aircell covering is good up to 300F and magnesia up to 600F; nevertheless, magnesia is permitted for temperatures as low as 213F and for any temperature in underground installations. There is a difference of only about 3% in the efficiency of fourply air cell and 85% magnesia and the choice of which is used is one more of physical consideration than of heat transmission. Pipe covering of cork is permitted only for brine and low temperature lines below 20F.

Wherever high-pressure steam is available it should be used at full pressure if feasible as this eliminates the need for reducing valves which are difficult to obtain quickly, and also enables piping for heating to be taken directly off of process mains, thus using only one distributing system for both process and heating. Radiators should be other than cast iron, but even where cast iron radiation is used it can be supplied with steam at about 15 lb pressure direct from the boiler, or in a high pressure system may be connected by a separate system of low pressure piping through a reducing valve.

Where steam at high pressure is available it should be utilized with at least 50 lb pressure, in which case the weight of piping saved will be about 75%, the weight in unit heaters saved 7% and the weight of steel saved in fan blast coils 16%, as compared with low pressure operation. The reason for fixing the pressure at 50 lb is shown in the accompanying table, from which it will be seen that the saving in weight is not so great with reasonable pressures above 50 lb as it is from 5 lb up to 50 lb pressure. Furthermore, the air temperature as delivered from fan blast coils at steam pressures above 50 lb cannot be controlled closer than 15 to 20F even with a by-pass. Incidentally, standard coils will take up to 200 lb. steam pressure and coils can be obtained which are good up to 250 or 300 lb pressure; on extra special order coils can be had which will withstand pressures up to 400 or 500 lb.

SAVINGS IN WEIGHT OF COILS AT VARIOUS STEAM PRESSURES

Steam Pressure, Lb	Per Cent Saving In Weight of Coils	
	Fan Blast	Unit Heaters
5	0	0
25	10	5
50	16	7
100	25	10
150	30	13
200	35	14

1-PIPE VS. 2-PIPE SYSTEMS

One-pipe steam heating systems should be used in preference to 2-pipe steam systems wherever they are more economical in weight. This is not always the case, for some systems are one-pipe in name only as concerns the mains, and the one-pipe connection to the radiator is usually of larger size than the supply pipe in a two-pipe system. Compared with vacuum systems, one-pipe systems must have larger pipes, as they cannot be sized on such a high pressure drop. On the other hand, vacuum systems require pumps with copper in the motor, but this disadvantage vanishes when the one-pipe system requires a condensate pump. One-pipe systems do not require radiator traps; however, the latter are now made with cast iron bodies and furthermore the one-pipe system requires air valves of brass and copper. Too, one-pipe systems cannot be used with unit heaters or with high pressure steam.

One-pipe systems which are not too lengthy may be designed so that the main extends as a loop back to the boiler so as to eliminate any need for a return or second pipe. Also, where the main can serve a floor above, the one-pipe system may economize on weight of metal. This is particularly true where there are two or more floors above served by one-pipe risers only slightly larger than two-pipe risers.

Where a one-pipe system must have the main located at the ceiling supplying radiators below the main, a return run is needed below the radiators, and in some cases extra piping to drip the supply drops is required. If the main can be run below the radiators at the floor this condition can be avoided, and the same is true of a similar condition in a two-pipe system, with the additional advantage in the latter case of eliminating the radiator drip traps and their cooling legs.

Forced hot water systems are usually two-pipe systems and use fairly small size pipes, provided they are not sized on the basis of gravity flow as sometimes done. Copper pipes formerly used are now prohibited, but steel pipes are satisfactory if made one pipe size larger than the sizes of copper pipes formerly used. Normally, these systems are sized on the basis of 200F water temperature; at this temperature they require 20% more in radiator weight than a one-pipe steam system, cast iron radiators are heavy enough without an additional 20%; in the case of light convectors, 20% additional weight is not so objectionable.

If these systems are sized on the basis of 215F water temperature the radiation required will be the same as with low pressure steam; only remaining objection then is that they require a stoker and motor for successful operation at this temperature which equipment would normally not be allowed for boilers of small size.

Forced hot water systems may be designed with a one-pipe main and two-pipe radiator connections. This makes for some saving in metal, provided that the system can be operated with 215F water temperature.

At any rate, hot water systems should be carefully checked for least weight of critical materials used as compared to some other system of heating, for in addition to the greater radiation required for hot water there may be additional weight of metal in compression tank, circulating pumps and motors, flow control valves, zone and other controls, and heat exchanger. On necessary alterations to existing gravity hot-water systems with proper size of boiler but with under-size radiators, conversion to a forced hot-water system may prove satisfactory and save on the installation of additional radiation otherwise required.

RADIATORS AND COILS

Manufacture of cast iron radiators is now limited to the tube type with short center sections weighing not more than 4.7 lb per square foot of radiation, though as manufactured they vary in weight from 4.0 lb to the 4.5 lb. Not only do cast iron radiators weigh more than other forms of radiation, but they require more piping to connect them, and therefore should be used only where they cannot be replaced by a unit heater, or some lighter form of heating surface. Another objection from a conservation standpoint is that their weight and that of the connecting piping cannot be reduced by the use of high pressure steam, as radiators of cast iron are not guaranteed above 15 lb steam pressure.

Radiators should not be wall-hung as this requires more labor, use of legless radiators which are not so readily available, as well as a certain amount of steel plate and bolts which, though only 1½% of the radiator weight, nevertheless represent steel unnecessarily used.

Convectors with non-metallic cabinets or enclosures are preferable in metal economy to cast iron radiators —3 lb per square foot of radiation in the case of cast iron convectors and 1.5 lb per square foot of radiation for steel convectors. Both types of convectors require enclosures; in the case of the cast iron convectors the enclosures must be built up on the job or obtained from another source. Furthermore, the cast iron convector cannot be supplied with high pressure steam whereas the steel convector can. When supplied with steam at, say 50 lb pressure, the weight will be reduced from 1.5 lb to 0.84 lb per square foot of radiation.

Extended surface radiation of steel tubing or pipe for use in continuous lengths is also manufactured for application without enclosures in 1¼ inch and 2 inch sizes with weights of 1.2 and 1.4 lb, respectively, per square foot of radiation. The 1¼ in. size is not available generally due to demands of the Navy and the 2 in. size cannot quickly be obtained.

Wherever radiators or convectors are required and the project can await protracted deliveries, this form of radiation should be substituted, as it is light in weight, requires no enclosures, and can be run in unbroken lengths as far as desired, or in accordance with the conditions so as to reduce the amount of branch piping required. It does, however, require a two pipe system in all cases, as compared to radiators or convectors which, in some cases, can be connected with less metal by the use of a one-pipe system. Extended surface pipe radiation will take up to 250 lb steam pressure and is particularly desirable where high pressure steam is available; in this case the weight of metal may be reduced substantially according to following table intended for room temperatures of 70F:

Pressure, Lb. per Sq. In.	Ratio of Weight to That at 1 Lb. Pressure	Surface Temp. of Fins, F
1	1.00	205
5	.90	...
15	.76	...
25	.67	...
50	.56	275
60	.53	...
70	.50	...
80	.48	...
90	.47	...
100	.45	...
125	.42	315

It will be noticed from the table that the weight of metal which can be saved is not so great above 50 lb steam pressure as it is up to that pressure. Also note that the surface temperatures of the fins are not high enough to be objectionable. Still other advantages are the coverage it gives against cold infiltration air currents due to its continuity, so that heat is evenly distributed; this is particularly desirable in certain manufacturing processes, such as an optical factory.

This type of radiation should not be provided with grille covers, even though these may be furnished in non-metallic materials, as such covers reduce the output by 3%, nor should they be placed two or three high as the output will be reduced 10 and 20%, respectively. When placed side by side, 1 in. apart, there is no change in output and when installed in flues for use as indirect heating units the output will increase by 12, 26, 38 and 49% for flue heights of 24, 30, 36 and 42 in., respectively.

Pipe coils, unless made of second hand pipe which would otherwise go to scrap, are not to be desired for they require too much steel, as indicated by the accompanying table. A study of the table discloses that from the standpoint of metal conservation more metal is saved by using the smaller pipe sizes and a small number of pipes per coil.

Pipe coils can be considerably reduced in weight by the use of high pressure steam, as in the case of extended steel surface, though temperatures corresponding to higher steam pressures would here be objectionable in most cases for a metal surface without fins or other secondary surface. Use of pipe coils is open to still further objections for the system must always be two pipe, additional weight of hook plates and bolts are required to support the coils and more labor is required because of these supports. The weights for hook plates and bolts have not been included in the foregoing table.

WEIGHT OF VERTICAL PIPE COILS (PIPES HORIZONTAL), IN POUNDS PER SQUARE FOOT OF RADIATION WITH 215F STEAM AND 70F AIR

No. of Rows	Pipe Diameter, In.		
	1	1¼	1½
	Weight per Sq. Ft., Lb.		
1	3.1	3.4	3.5
2	3.2	3.5	3.8
4	3.7	3.9	4.2
6	4.3	4.7	5.0
8	4.9	5.5	5.7
10	5.5	6.0	6.4
12	5.9	6.5	6.9

UNIT HEATERS

Considerable savings in metal can be made by the substitution of unit heaters for other forms of radiation. Both heaters and piping require much less of metal, usually only a central main is required, and they also can be operated with high-pressure steam with further reduction in weights. At times and in certain localities there have been delays in securing the motors necessary for their operation and these motors and their wiring use a certain amount of copper; the savings in metal are worthwhile and in the case of belt-driven units the motors are frequently obtainable second-hand.

Heating equipment of metal is only to be used to the extent that non-metallic materials are not available and competition soon brings about this availability, just as it now has in the case of unit heaters. At least one large manufacturer of such units is now in production with heater casings and louvers constructed largely of non-critical material, so that the use of unit heaters becomes much more desirable than heretofore. Units which formerly weighed from 45 to 500 lb now have metal weights of only 33 to 400 lb and blower type units which formerly weighed from 500 to 1000 lb in the larger sizes now contain only 250 to 500 lbs. of metal.

Thermostats and their wiring take brass and copper; nevertheless they should be used as they usually save fuel, though only one should be used for each unit heater.[1] Group control

[1]Thermostats should be eliminated entirely where there is an excess of exhaust steam for heating purposes and also where the unit heaters are located in offices where they can be readily controlled by manual operation.

of units by one thermostat usually saves nothing on wiring; in fact such method of control may even increase the amount of wiring required.

Circular air diffusers often used below projection type unit heaters were formerly made of aluminum, later changed to steel, and now are being produced in limited numbers by at least one manufacturer of non-metallic material. A stock of metal diffusers is still available to be drawn upon, but specifications should call for non-metallic circular air diffusers, except where non-metallic diffusers are not available.

DIRECT-FIRED HEATERS

Traditional methods are being examined and frequently rejected in favor of practices that have received recognition as metal conservers. The direct-fired warm air heater is a striking example of this. Such heaters, with fuel burners included, and especially the self-contained shell type, require the least weight of critical materials within their range of sizes of any type of heating system This saving, in critical materials may amount in many cases to over 50 and even 75% of the metal required to install a comparable heating system of other types, and some government agencies have ruled that where the engineer's estimate shows the direct-fired system to be of lighter weight than any other, the lowest metal weight of the bids can be accepted. In the case of plants requiring steam for domestic hot water supply there is still a great saving in metal by using a split system, even where process steam is required. Direct-fired units do not have to be sized for large piping and pick-up factors, and this is an advantage where metal conservation is involved.

Heater motors are belt-driven, hence have a greater possibility of being obtained second-hand as compared to the direct-driven integral fractional horse-power motors on unit heaters. Fans furnished with the heaters can be speeded up so as to give slight increase in capacity.

Both direct-fired warm air heaters have an advantage in that they can furnish ventilation in summer months, using 100% outdoor air, and may also be used for ventilating purposes at times in the winter months, where allowed

The direct-fired warm air heater may be obtained from at least one manufacturer with non-metallic casings and quite often with second hand motors for air delivery and induced draft fans. Brick or concrete bases are used for foundations and the stacks (which are of small diameter and low height due to the use of an induced draft fan) should be non-metallic. Heaters require stokers for increased capacity and efficiency and the weights of such heaters, including the weight of the stokers, are approximately as given in the accompanying table. Heaters may be connected to ducts and these ducts should be of non-metallic construction, except for metal required for connectors and hangers. The metal required for this purpose is about 10 to 15% of the metal required for all-metallic ducts. In some cases the heaters may be without ducts, depending upon conditions. Heaters used should be few in number[1] unless this involves an unreasonable amount of duct work; for example, a load of 4,000,000 Btu would be handled, if possible, by one heater weighing 18,300 lb rather than by four heaters which would weigh a total of 32,000 lb and require more man hours for attendance.

Larger units up to 8,000,000 or 10,000,000 Btu per hour output are available to suit special conditions. When burning coke, heaters do not require stokers, but do require a forced-draft blower, as required with coal when hand-fired. Coal-fired heaters can be fired with oil or gas if changing conditions make this desirable. Oil-fired heaters are lighter in metal weight than those of equal size when stoker-fired, but as may be noted from the table they are not made in the larger sizes, and in any event the overall weight of the oil-fired warm air heating system would be about the same as the stoker fired system due to the weight of oil pumps and oil piping required, as well as the weight of steel reinforcement in concrete fuel oil tanks. Oil-fired heaters are allowable only in those states where the use of oil fuel is permitted for space heating.

Space requirements for the heaters are not great (but where space within the structure is more valuable for other purposes heaters may be installed in exterior extensions), heaters may be quickly installed, require little labor, have considerable salvage value, even heat is provided, dust is not a nuisance, and the heaters are very economical of fuel.

Efficiencies of direct-fired heaters are high and the heaters will operate at a point near their maximum efficiency obtainable. Still another advantage is that the cost of the direct fired warm air system should be low, since no boiler house or connecting tunnel are needed, although this may be somewhat offset by the cost of the ducts where the job is small and the contractor unfamiliar with the installation of non-metallic ducts. Incidentally, the use of concrete ducts run below the floor should be avoided generally, as such ducts may require steel reinforcement, have high heat losses due to the high air velocities over the dense and perhaps moist concrete, and make unequal and therefore wasteful air temperatures along the runs due to such heat losses. The heat losses are particularly noticeable where underfloor ducts are run near and along the north wall of a structure.

Investigations on direct-fired warm air heaters disclosed that the metal in certain makes of the oil and gas-fired types could be lightened somewhat and this was done in the case of these types only.

[1] At present heaters of the smaller size are more quickly obtainable and must be used where larger sizes cannot be delivered without delaying war production.

METAL WEIGHTS IN POUNDS OF STOKER-FIRED DIRECT WARM AIR HEATERS.

B.T.U. Delivery per Hour	Oil-Fired	Coal-Fired	Air-Circulated, C.F.M.
	Weight of Metal, Pounds		
650,000	4000	8500	8500
750,000	4000	8000	8500
850,000	4200	....	10000
1,000,000	4800	8000	10000 Oil 11000 Coal
1,100,000	4800	....	12000
1,250,000	5000	....	13500
1,350,000	5700	....	15500
1,500,000	6800	11000	15500 Oil 17000 Coal
1,650,000	7100	11500	18000
2,000,000	....	.....	20000
2,500,000	....	15000	27500
3,000,000	....	15300	33000
3,500,000	....	18000	38500
4,000,000	....	18300	44000

NON-METALLIC DUCTS

Millions of pounds of steel have been saved by using ducts made of asbestos fiber mixed with special cements under hydraulic pressures so as to form sheets of various thickness, the usual thickness being 3/16 in. with a weight of 2½ lb per square foot. Many construction companies are by now quite familiar with such products and each has adapted his own particular method of installation, some being sheet metal connectors of No. 24 gauge for joining sections while some find that cementing and taping the joints makes a quick and neat appearing job.

Asbestos has acoustical properties which make it possible to erect asbestos ducts to convey air with little noise at much higher velocities than in a metal duct. For example, air flow at a velocity of 2000 fpm is more quiet in an asbestos duct than it would be at 1200 fpm in a sheet metal duct, and because of these higher velocities the ducts are smaller and the load on the supporting structure is less.

Asbestos ducts can be safely exposed to the weather in which location they will harden with age. They will also withstand the high air temperature of dry kilns and other apparatus and also any degree of moisture as moisture serves but to harden the asbestos. However, asbestos ducts are not to be recommended for the removal of low temperature acid fumes. In such cases condensation forms and builds up until the high concentrate of acid in time disintegrates the cement binder of the asbestos. This is particularly true with sulphuric, muriatic, and chromic acids, common in plating departments. How rapid the deterioration will be depends upon how frequently the tanks are operated and the amount of dilution with room air.

Asbestos ducts are, however, being used by some contractors for acid conditions and so far appear to be giving good service, particularly so when painted with black asphaltum. Considering that present day construction is intended for temporary usage, asbestos ducts should be given more wider use for acid fume removal, especially where the gases are at high temperature and the ducts are accessible to stop fume leakage. When materials were plentiful it was common to use for acid fume removal ducts of stainless steel or asbestos ducts injected with chemically resisting compounds, but both items cannot now be obtained. In places where renewals can be conveniently made, light-gauge sheet metal painted with black asphaltum can be used.

VENTILATION and CONDITIONING

One of the greatest problems in connection with large scale exhaust systems is the large volume of heated air which must be discharged from industrial buildings, with resulting first and operating costs. The amount of air exhausted must be replaced by an equal volume of heated air and just how to do this without using cold outdoor air which generally requires the use of critical materials is a problem which can only be met upon rare occasion.

The difficulty is especially acute when production methods require the use of large spray booths. Water wash paint spray exhaust systems, which use a great volume of water for washing purposes, have provided the answer to the many serious objections to paint spraying in that they have eliminated exterior discoloration of buildings and other nearby objects and have also practically eliminated fires in exhaust stacks. Although such systems are very efficient in removing pigment and other solids they do not remove the volatile solvents in vapor from the exhaust air. In addition to the obnoxious odor of most of these solvents, many of them, such as benzol and methanol, have a toxic effect on humans. The exhausted air is also high in moisture content, being very close to saturation. Many Army and Navy specifications require humidity control when applying zinc chromate to prevent relative humidities in excess of 40%. A combination of all of these conditions excludes the practicability of returning such exhaust air to the building, so that make up air must be heated to 80F, and this air must be introduced at the booths so that the dust content of the air does not affect the paint.

In the case of dust and lint removal such as is incident to the operation of buffing stands and grinders, a centrifugal water-type air reclaiming unit, together with an after-cleaner of the fabric type, may be used for discharge of the reclaimed air directly to the space, thus eliminating any need for making up outdoor air. Electrostatic air cleaners can be used with some forms of dust, and in the case of spray booths and plating tanks, air can at least be recirculated when the spray booths and the plating departments are not in operation, thus saving fuel. Likewise fuel may be saved and metal may be also conserved in many other ways, such as by the introduction of air with or without the use of deodorizers as exhausted from areas ventilated by supply air only or from other areas which require exhaust due to overheating from processes*, by the introduction of cold replacement air in a duct enclosing the heated exhaust air duct which would, in turn, heat the entering air, or by introduction of cold air directly near the points of exhaust. Air can also be introduced cold at overheated areas, such as at high ceilings, through a recently developed type of circular air diffuser which can be quickly adjusted for horizontal flow along the ceiling in the heating season and for downward flow in the non-heating season. In any event, the method of exhausting at processes should be designed for most efficient removal with the least amount of air exhausted and with a system so flexible that only the equipment in operation need be exhausted. Heat treatment areas can be partially enclosed and exhausted at large hoods and outdoor air can be introduced into such areas directly without conditioning.

Ventilation is allowed only for blackout buildings when such buildings are authorized, for operating rooms, kitchen range exhaust hoods, and for removal of smoke, gases, fumes, heat or dust from processes. In general, cafeterias, kitchens, dark rooms, toilets, and locker, wash and rest rooms should be located along outside walls where they can have window ventilation. However where the journey to the rest room is too long and the man hours become more critical than the materials involved, as in some buildings of large area, it may be necessary to have several small rest or wash rooms located at intervals along the longitudinal center line of the building. If ventilation is provided for inner spaces it should be by means of louvered doors for inlet air and non-metallic gravity ducts and ventilators for exit air. Ducts can be made of size sufficient to take a fan after the war, or in extreme cases a second-hand fan might be warranted. Interior dark rooms as a rule require powered ventilators unless air is supplied to the

*Some war plants have more than enough process heat to comfortably heat certain areas in the winter months without a heating system, so that the excess should be used for some other area, thus making both areas more comfortable.

room by a duct system, in which case the air can be vented by means of a gravity duct. Upon occasion, locker rooms, wash rooms and offices have been supplied with heated outdoor air, venting through sufficient relief areas or exhausted by fans (after deodorization) to the high points of large manufacturing areas. In this way the advantage of supplying outdoor air to such rooms was obtained where it would not otherwise be allowed, because the amount of air exhausted or relieved from such rooms would take the place of an equal amount of heated outdoor air otherwise required for makeup to the manufacturing areas which usually have a great amount of exhaust from the various processes.

Every conceivable space is now utilized in factory plants, so that it frequently happens that basements also become crowded with occupants and heat producing equipment and must be ventilated. Exhaust ventilation should not, however, be accompanied with outdoor supply ventilation if the air can be drawn from other building areas. If air can not be drawn from other areas, the exhaust ventilation should be by gravity exits and the supply air taken from outdoors and heated as required. Oil mist or haze from the large quantities of oil coolants used for grinding wheels and other oil-cooled machinery is also creating quite a demand for ventilation and especially so in blackout buildings.

Kitchen range hood exhaust should be limited to a velocity of not over 100 fpm over the hood area or not more than 360 cfm per foot of hood length. In alteration work the need for additional boiler capacity can sometimes be eliminated by checking over the plant conditions with a view to recirculating (with or without deodorizers) all or a part of the air previously taken from outdoors. Stacks from forges should have gravity non-metallic exhaust hoods with non-metallic ducts directly upwards and out, or should be collected together with smaller size of ducts to a fan, whichever method gives the least weight of metal. Ventilators should be non-metallic type whether powered or not, but rotary wind-blown ventilators, where such type is required, are not available of non-metallic materials. Hoods over ranges, steamers, and similar kitchen equipment should be constructed of cement asbestos board or similar products, but angle-iron frame work, channel iron for gutters and iron hangers will usually be required.

When ventilation or air conditioning is necessary and allowable, the question arises as to just how limited the outdoor air supply can be and still maintain reasonably satisfactory conditions within the space. From the standpoint of economy in critical materials it matters but little whether the outdoor air is introduced into the building by a fan and heated by passing over steam blast coils or whether it infiltrates and is heated by unit heaters. More comfort and slightly less material is required if the outdoor air is heated at one point by the blast coils, and where this is done the heating calculations should deduct the air change loss from the unit heater load. The extent of air change is dependent upon exposures and volume of space but should never be over one air change† per hour to maintain the heated space under sufficient pressure to retard infiltration.

The volume of outdoor air is also determinable in accordance with the plant population and the amount of outdoor air required per person. Usually the amount of outdoor air required to keep the space under pressure in the heating season is sufficient to provide at least 15 cfm per person because the cubic feet of air space per person in war plants is at least 1000 to 2000 and may go as high as 3000 to 5000. However, this figure can be reduced to as low as 300 and still provide 5 cfm per person, a quantity which in the writer's judgement is sufficient.

The extent to which a space must be kept under pressure in summer is not so great as in winter, and as a consequence the outdoor air quantity of 5 cfm per person may become the determining factor rather than the air change; in other words, the usual allowance of 10 to 15 cfm per person may bring about a pressure condition within the space which is much greater than that required to offset infiltration losses. Taking the minimum previously mentioned of 1000 cu ft of space per person and one air change per hour in the heating season there would be an allowance of 17 cfm of outdoor air in the winter months, while on the hottest days in the summer, seldom accompanied by strong wind velocity (say about one third the winter velocity), the allowance necessary to offset infiltration would be only about 5 cfm.

Over the past thirty years engineers have seen the estimated quantity of outdoor air required decline from 30 cfm to now generally accepted 10 or 15 cfm. Today he occasionally hears discussed the possibilities of further dropping this figure to 5 or even 3 cfm. To this the writer would add the thought that in some war plants the air space is so great per person that the person could live almost indefinitely without outdoor air. Formerly 30 cfm was thought necessary for diluton of carbon dioxide; later the thinking changed to the belief that removal of body heat was the determining factor. Strangely enough, the quantity required to accomplish this was not adopted for a long time, after studies were made coincident with the greater introduction of air conditioning and the limitations imposed on such introduction because of the magnitude of the outdoor air load.

Roughly, and in the average temperature zone in the United States, the outside air load will require an average of three tons of installed refrigeration, 100,000 Btu per hour of installed boiler capacity and radiation for each 1000 cfm, the expenditure in summer of one kilowatt, and in winter one half gallon of fuel oil which in these days of 24-hour operation can mean 2500 kw-hr and 1500 gal of oil per year per 1000 cfm. It is therefore everyones immediate and vital concern to see that no more outside air is introduced than is absolutely necessary.

In recent years adsorption has been applied to ventilation for the removal of odors, gases, or vapors which might be harmful or undesirable. A suitable adsorbing medium is coconut shell activated carbon and this can be used for the removal of odors from toilets and wash rooms, locker rooms, rest rooms and many other places. Use of such equipment may enable a reduction in outdoor air and a consequent saving of materials.

Important savings of critical materials may be made in air conditioning systems by the elimination of evaporative condensers, except where pumping of water would involve more of critical materials, and by elimination of steam or hot water reheat. Furthermore, considerable second-hand air conditioning equipment is now being removed from comfort installations for re-use where vital processes require air conditioning. In some cases duct systems now by-pass formerly conditioned offices and instead deliver conditioned air to the points where process dictates its use.

When air conditioning is required for process it should be confined to the smallest possible areas. Roof sprays should not be used to reduce the transmission load where the ratio of the roof load to total load is not enough to warrant the quantity of piping and water that would be required.

Where workmen come from conditioned work areas to cafeterias it may become necessary to condition the cafeteria as well, but in such cases the cafeteria temperature differential can be one third or one half that of the conditioned work areas.

Blast coils for heating should be of steel rather than cast iron as the weight of cast iron blast surfaces is

†To this must be added an amount of outdoor air equal to the amount of any exhaust air.

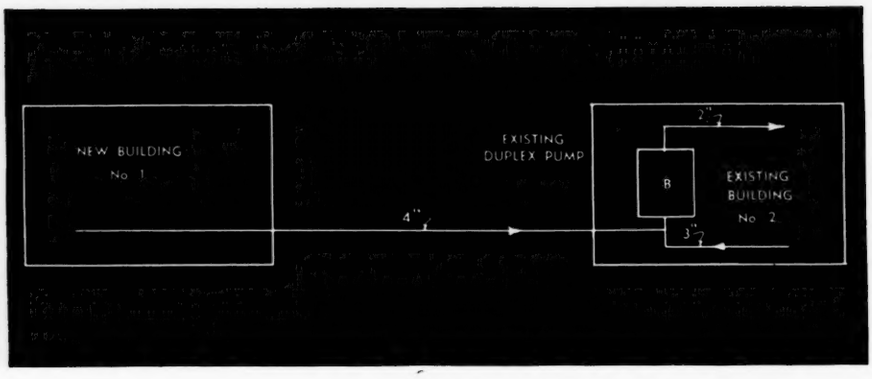


Fig. 1.

far in excess of the weight of steel coils. An analysis of three specific jobs, one of fairly large size (50,000 cfm), a medium size (25,000 cfm), and a small job (10,000 cfm) with air heated from 0 to 85F gave 24,192, 11,610, and 4,749 lb respectively of cast iron, as compared to 4,045, 1,928 and 856 lb, respectively, for steel, or a ratio of 6 to 6½ to 1 in favor of steel. Cast iron blast heaters also require heavy foundations, extra labor for handling, additional space and weight in transportation and more of valves, pipe and fittings, and cannot be reduced in weight by the use of high pressure steam as can the steel coils. Steel blast coils with nonmetallic casings are now available which save 10% in weight of metal.

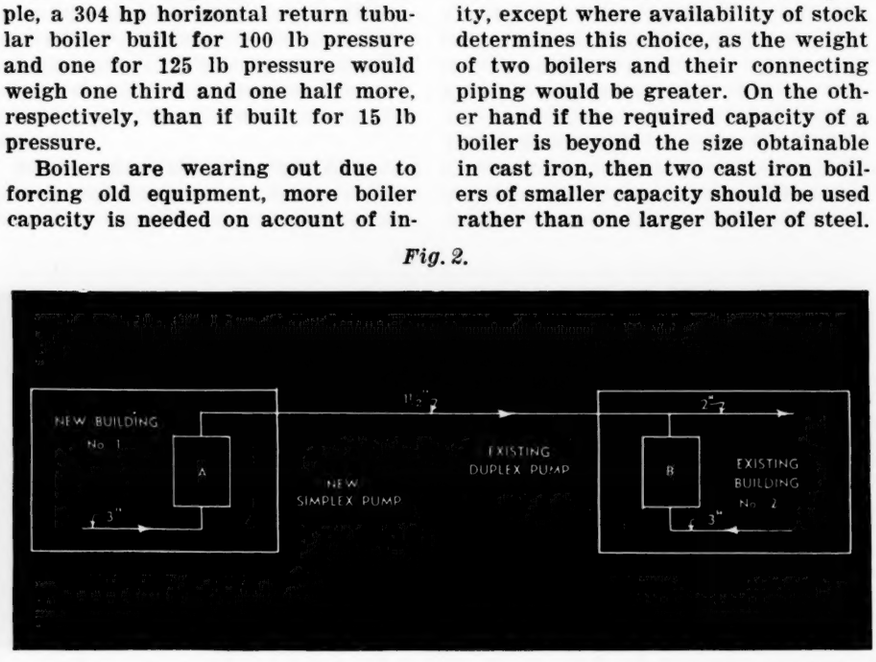
BOILER PLANTS

Boilers, where required, are allowed to-day only of cast iron, except where capacity and high pressure process requirements make steel absolutely necessary, in which event an earnest effort should be made to locate a second-hand steel boiler. Production of cast iron boilers is now somewhat limited. Furthermore, such boilers weigh about twice that of steel boilers of the same capacity; nevertheless, cast iron boilers are to be preferred since steel boilers need critical steel plate for their construction. Steel boilers should not be built for higher pressures than present needs as their weight increases rapidly with increase in pressure. For example, a 304 hp horizontal return tubular boiler built for 100 lb pressure and one for 125 lb pressure would weigh one third and one half more, respectively, than if built for 15 lb pressure.

Boilers are wearing out due to forcing old equipment, more boiler capacity is needed on account of increased war orders, or boilers cannot be laid up for repairs without stopping production, so that on every hand there is a demand for boilers. Such demands may be met in various ways—by adding boiler sections, obtaining second-hand boilers, adding a stoker to increase capacity, forcing the boiler even if the effect is one of shortened life and lowered efficiency, adding a direct-fired warm air unit heater to take the additional heating load, connecting to street steam, or even connecting to a locomotive for temporary use while boiler repairs are made or the old boilers replaced.

One large boiler should be used in lieu of two boilers of smaller capacity, except where availability of stock determines this choice, as the weight of two boilers and their connecting piping would be greater. On the other hand if the required capacity of a boiler is beyond the size obtainable in cast iron, then two cast iron boilers of smaller capacity should be used rather than one larger boiler of steel.

Fig. 2.



Any existing boiler capacity should not be scrapped and this capacity combined into the new boiler unless required for equalization of water lines and evaporating rate. This situation is more pronounced where one boiler is cast iron and the other steel; the problem can sometimes be solved by placing one boiler on domestic hot water supply or process and the other on the heating load. Boilers should be sized with no allowance for pick-up where 24 hour operation is contemplated; where the operation is not continuous the boiler can be forced and run at lowered efficiency during the short interval of time in which pick-up occurs.

Stokers. Stokers which have a maximum coal feeding capacity not in excess of 60 lb per hour have been discontinued in manufacture, but are still available from stock. As with boilers, stokers should not be split into two of smaller size where one would answer the purpose except where the vailability of the smaller size determines the choice. For example, two 300 lb per hr stokers would weigh a total of 3600 lbs whereas one 600 lb per hr stoker would weigh only 2100 lb.

Stokers should be used only on the larger installation where common labor is not available for hand-firing, where needed additional boiler capacity can be obtained by this means without boiler replacement, where an undersize second-hand boiler can be brought up to capacity through the use of a stoker, where even heat is required for process (as in an optical factory), where forced hot water systems are operated with water at a temperature as high as 215F, or where there is an all-unit-heater installation. The type selected should be one of least weight consistent with coal and boiler requirements, and an effort should be made to obtain the motor second-hand or the stoker should be turbine-driven. Stokers should not be used on boiler replacements where there was no stoker previously and no demand for increased boiler capacity. Automatic water feeders should not be used where the system is not automatically fired.

Water Treatment. Treatment of boiler water involves quantities of critical materials varying with the method used, and the method varies with the plant locality, and the opinions of the engineer. There seems to be no way of avoiding the need for such treatment in many cases; at least it must be used in the case of steam plants generating steam solely for the operation of steam hammers which have exhaust steam as the end product rather than returnable condensate and where only a small amount of exhaust steam can be reclaimed for heating.

The relatively small amount of

water that can be returned in such cases does not justify the use of much return piping and the several motor-driven condensate pumps needed to effect its return when the percentage of raw water make up would be high in any event. Some form of feed-water treatment is then imperative to avoid interference with production.

Lubricating oil for hammer cylinders combines with the sludge formed from untreated water and causes undue wear on the hammer cylinders and a dirty condition which prevents proper lubrication of the cylinders, so that speed of hammers become sluggish with production curtailed. Oil is returned in excessive quantities past the overloaded oil separator to the boiler, where the tubes soon become incrusted and more sludge and wet steam are then carried over to the hammers to aggravate the condition. This low quality of steam may cause cylinder heads to be blown off or pistons to crack and, in any event, will wash more oil from the cylinder walls, further continuing the cycle, with frequent lay up of hammers for servicing and of boilers for cleaning and tube replacements.

Feed Water Heaters. The need for boiler plant equipment should be carefully thought out. Will stokers or pulverizers require the least weight of critical materials; will the fuel saved by economizers really compensate for the metal they require for their manufacture; is duplex equipment vital to plant continuity; are the pressures such that a cast iron feed water heater may be used rather than one of critical steel plate?

Stacks. The chimney should be located relative to the boilers for short run of breeching, which should be of light gauge even if this means renewal in a shorter interval of time, and should certainly be kept under 3/16 in. in thickness even though this requires an additional weight of angle-iron reinforcement.

Steel stacks are seldom allowed today except second hand, but when necessarily used should be under 3/16 in. thick even if a greater weight of reinforcement is necessary. Steel stacks should be used where it is found that the metal required to build breechings connecting with masonry stacks, plus any reinforcing steel in stack foundation if on made ground, is greater than the weight of metal required by using steel stacks. Masonry stacks also require ladder rungs, cleanout doors, and a lightning rod. The latter, including ground plate, should be of ferrous metal throughout. A ⅜ in. steel cable or rod will answer the purpose.

Coal and Ash Handling Equipment. The most economical method of handling ashes from a standpoint saving critical materials, varies widely. In som cases a pneumatic pipe line ash conveyor system is best, but not in others, since restrictions on such forms of ash-handling equipment as mechanical conveyors have practically left only the moving machinery metallic, all else non-metallic.

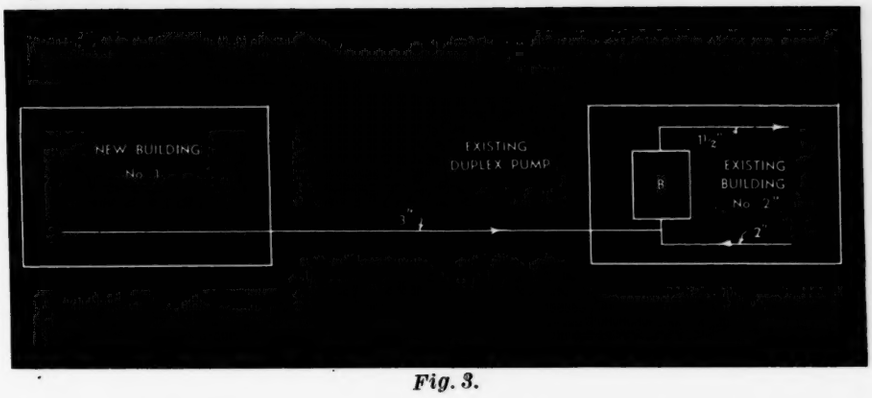


Fig. 3.

The great weight of metal enclosures and structural steel supports formerly commonly found in mechanical conveyors has been sharply reduced by substitution of wood, in some cases light-gauge sheet metal, or wood with light-gauge sheet metal lining; these substitutions, together with the possible use of second-hand motors makes the case for mechanical conveyors fairly reasonable.

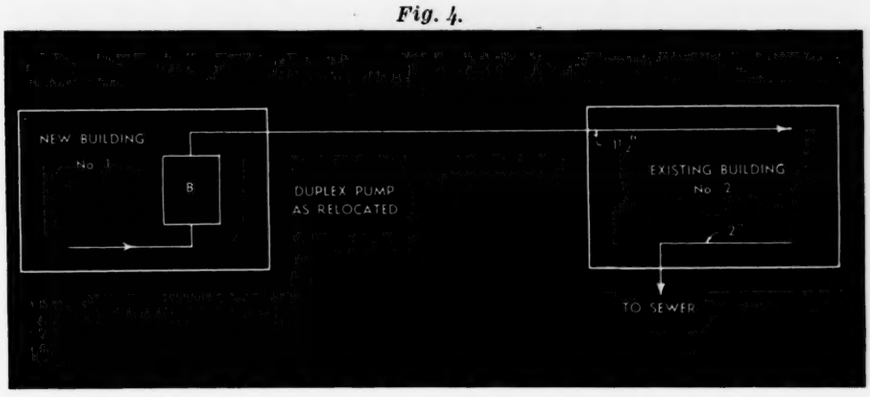
All proposals on various methods of ash handling should include weights so as to determine which method requires the least weight of metal. This also applies to coal-handling systems. For example, a simple monorail system using second-hand rails might serve the purpose, or new rails weighing not over 60 lb per yard might be desirable.

Pneumatic ash-conveyor systems should be checked for elimination of all possible items of a metallic nature. The more critical materials have now been eliminated from the manufacture of the conveying pipe line and the special grade of cast iron used for this is probably less critical than ordinary grey cast iron, since it is made from a far lower grade of scrap. Ordinary cast iron has a short life when handling ashes, especially at bends. The ash storage bin should be located for the shortest run of conveying pipe line, as by far the greatest part of the metal weight in this type of ash conveying system is in the heavy pipe line.

Ash storage tanks should not be constructed of steel plate. Such tanks are usually of glazed vitrified tile, steel-banded, with reinforced concrete floor, and tile carried to the ground, or with reinforced concrete columns to eliminate structural steel supporting columns. Solid concrete for the floor or supports would be too massive. Various other substitutions have come about, such as wood for platforms, exterior ladders, and for railings on roof of ash tanks, for supports for conveyor pipe lines and for cover plates for the conveyor trench, except where ashes drop on the floor in which case concrete floor slabs are substituted for the wood cover plates.

Pumps. In some cases where a condensate pump is needed to return the water it can very well be omitted and the condensate run to the sewer with a resulting loss in fuel not too great, considering the urgency of metal conservation. A pump not only requires steel, iron and copper in itself, but quite some copper wiring and steel piping for waste and pump discharge, so that while the return of condensate may be justified economically from the fuel and water saving involved, it may not be justified from a metal standpoint. Returns can also be wasted where there is an excess amount of exhaust steam, providing this does not cause such a high percentage of raw water make-up to the boilers that extensive water treat-

Fig. 4.



ment apparatus becomes essential. Sometimes the physical conditions requiring a pump can be removed by using a boiler with a lower water line or by designing for a boiler room at a slightly lower level, unless such a design necessitates reinforcing steel or other items of a critical nature, or a few radiators may be removed and unit heaters substituted, so that condensate can return by gravity direct to the boiler.

Vacuum return pumps effect a reduction in pipe size and as a consequence are desirable on sizeable jobs where the saving on pipe can be appreciable or even on smaller jobs where a condensate pump would otherwise be required. The weight of a vacuum return pump over and above that of a condensate pump is only about 100 to 1200 lb, increasing with increased size, though the motors are much larger. Duplex pumps providing standby should not be used, due to the additional pump, motor and valves which increase the weight of condensate pumps 250 to 550 lb in the larger sizes and the weight of vacuum return pumps 300 lb to 1000 lb in the larger sizes. Duplex pumps are not objectionable where both pumps are reduced in size so that both must run together at maximum load; in fact, this should provide a satisfactory method (even though for certain sizes the total motor horse power may be slightly larger), since, in effect, such an arrangement provides a standby motor and pump except for the few days of maximum load.

Selection of pump size should be made with a view to weight limitations. Thus, upon occasion, a larger motor might be used to cut down the size and therefore the weight of a long pump discharge line. Assuming a load of 14000 sq ft of radiation with a 20 lb discharge head, a vacuum return pump might be selected having a capacity of 20000 sq ft to be on the safe side. This size would require a 2 hp motor while a pump of 15000 sq ft capacity and only a 1 hp motor is probably sufficient, especially so considering that there are only a few days of maximum load. Vacuum return pumps are rated with an excess capacity of 300% and there is no pick up load in 24 hr industrial plants.

Pumps should be selected with receivers of cast iron and not of galvanized steel. With some pumps there is a possibility in substituting wood for the heavy separate cast iron base, where wood bases will serve for proper lining up of motors and pumps.

A pump should be located at the nearest possible point after the last return line connection so as to reduce the weight of metal by the difference between the size of the gravity supply and the pump discharge lines. Consider also the savings in money and metal made by comparing the pump installation in Fig. 1 with connections as made in Fig. 2, and compare a similar situation which was proposed as in Fig. 3 with revisions made as illustrated in Fig. 4. There was quite some distance between these buildings. Building 1 was new, Building 2 an existing with a duplex pump which, when relocated in Building 1 (Fig. 4), was operated with both pumps running to obtain the increase in capacity desired, the small amount of condensate in Building 2 being wasted. Pump A in Building 1 is a new pump of Simplex type.

OIL-COAL CONVERSIONS

Oil can be said to be more critical than the commonly-used metals, and the restrictions pertaining to its use run counter to and have priority over the usual conservation of materials. A large amount of metal goes into the multitude of oil-coal conversions of industrial plants, but is well worth while especially where the cost of conversion does not greatly exceed $3 per barrel of fuel oil saved annually; for example, if the conversion from oil to coal saved 42000 gallons of oil (1000 barrels), an expenditure of $3000 for the conversion would not be considered unreasonable.

These conversions usually require a considerable amount of new materials in stokers, coal and ash-handling equipment, change of boiler fronts, raising of boilers for increased combustion space, etc. Sometimes less metal is used by obtaining second-hand boilers and equipment and erecting them in a cheaply constructed temporary boiler house near a railroad siding. Stokers should not be used for installations which were hand-fired before converting to oil, nor for the smaller boiler sizes, except in the case of boilers having tankless heaters. In the last case it is more in the interest of conservation to use a stoker than a separate coal-fired heater with tank and connecting piping. Of course, each situation should be given careful study; there is no point in installing an ash-handling system for medium-size boiler plants just for the duration, and if it is necessary the ash system should be of the most simple type.

Coal handling equipment, if necessary, should be second-hand wherever possible, critical steel plate 3/16 inch and over should be avoided, chutes should be of No. 10 gauge, hoppers of wood, metal lined, modernization should not accompany the change over, and as few boilers should be converted as possible, utilizing the few at increased ratings. In some cases the use of critical steel plate can be avoided, by substituting two sheets, say two 1/8 in. thick for one plate 1/4 in. thick. The demand for plates for shipping has taxed the facilities of the plate mills whereas the rolling mills are not relatively so busy.

FURNACES (WITH BLOWERS)

While selection of warm air equipment should be made among those types utilizing the least amount of metal, there is little choice now, for most manufacturers have reached the allowed production quota. Manufacturers who previously produced less than 8000 furnaces annually were restricted in 1942 to 90% of their 1940 output in total weight of iron or steel, while those manufacturers of greater output were restricted to 50% and, as a consequence, the need for a very large furnace must often be satisfied with two furnaces of smaller size of equal total capacity but of greater weight for the two.

Furnaces of cast iron are made of from 20 to 30% of pig iron with the balance of scrap iron, which is not considered critical. The weight of cast furnaces will exceed the weight of steel furnaces of equivalent capacity by from 150 to 200 lb per furnace in the domestic sizes. Larger furnaces, say those with 1,000,000 Btu capacity will weigh 9000 lb in cast iron and 7500 lb in steel. Furnaces of steel are made up from 50% of pig iron and 50% scrap. Steel is usually No. 10 gauge but is sometimes much heavier. Furnaces of 3/16 in. plate or greater should not be used, as plate of these thicknesses is critical.

Metal jackets are customarily galvanized, though some are of black iron, but this is of little importance because one must select from a limited stock.

A fan filter furnace system or a central fan with boiler and steam coils, even when connected to non-metallic ducts will not necessarily weigh less in metal than a unit heater system. Much depends upon the particular case as to which system is preferable.

Furnaces should be located for central distribution of ducts and short runs of smoke pipes.

Fig. 1. General view of air conditioned observation room, showing air outlet, recording thermostats, float pan, regulating valve for refrigeration, and time switch.

RELATIONSHIP OF DISEASE AND WEATHER

is being studied at Northwestern University Medical School in a room air conditioned and under complex control. System described by Herbert Kreisman, Vice-President of Advance Heating and Air Conditioning Corp., Chicago, engineers and contractors.

THE medical profession has long been aware of the relationship between weather and certain physiological reactions in the human body. For example, sufferers from arthritis commonly complain of increased discomfort during periods of high humidity and, as a matter of fact, are frequently able to foretell climatic changes with surprising accuracy by increased discomfort or pain. Asthmatic conditions are often directly related to air temperature and humidity, and a dry climate may prove highly beneficial. Artificial production of fever by subjecting the patient to scientifically controlled temperature and humidity environment is producing surprising results in the treatment of syphilis. These are but a few of the many diseases that have been found to react to air temperature and humidity.

Air conditioning is now doing its part in a study to determine just what part atmospheric conditions play in the diagnosis and treatment of diseases. The Medical School of Northwestern University is at the present time actively engaged in investigating the relationship of temperature and humidity and certain respiratory ailments. From the results of these experiments air conditioning might be indicated as a necessary part of the treatment in handling many common ills.

The technique of these experiments consists of artificially producing certain respiratory and pulmonary conditions in animals by irritants or other agents, and then placing the subjects in an air conditioned observation room, where the temperature and humidity can be controlled with a fine degree of precision over a wide range of conditions. The animal is periodically examined at regular intervals to determine the reaction with respect to time, extent of recovery, if any, or the period elapsing before death ensues.

Air Conditioning Problem

Insofar as conditions in the observation room were concerned, the physiologists at Northwestern presented the problem of maintaining the space at any point between 60F dry bulb and 40% relative humidity to 100F and 95% relative humidity, with an allowable variation of plus or minus 2F and 2½%. It was felt that these extremes were adequate to evaluate satisfactorily the resulting effects. The required flexibility of the desired system is reflected by the fact that the experiments were to be conducted in a series, first maintaining the dry bulb temperature constant and gradually and intermittently raising the humidity between the low and high

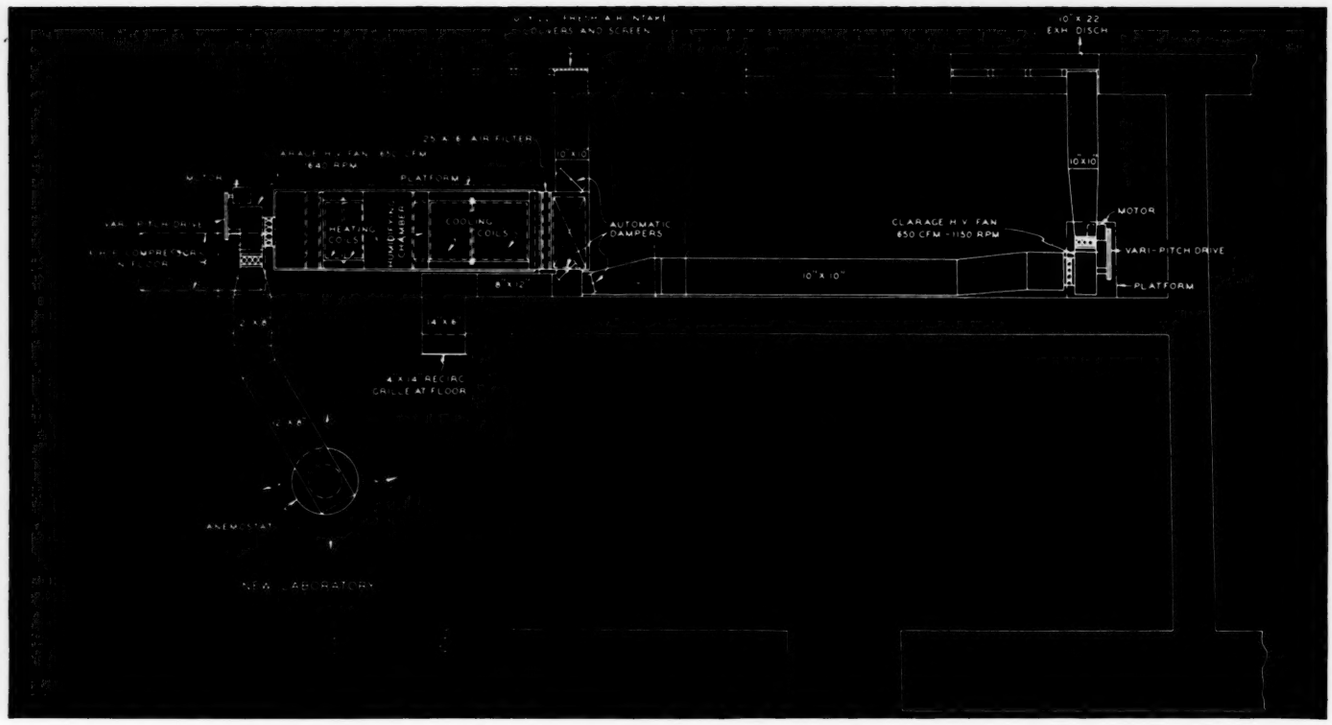


Fig. 2. General arrangement of air conditioning equipment and its relation to the laboratory.

points, and, after that series of experiments were performed and evaluated, maintaining a fixed relative humidity and varying the temperature through its whole range. Inasmuch as data were required for various relative humidities (while changing the dry bulb temperatures) and various dry bulb temperatures (while changing the relative humidity), and inasmuch as *change* in physiological reaction was as important as absolute values, the system had to be designed to meet practically all possible combinations of temperature and humidity, and furthermore had to *control* temperature and humidity under each condition.

The air conditioned room is approximately 9 ft by 9 ft by 7 ft, occupied by eight animals. The small volume of the quarters complicated, rather than simplified, the design and performance of the system, as the question of air motion and drafts had to be handled delicately so that the animals would not be subjected to exterior disturbances which might affect their physical well being. The smallness also rendered any departure from design conditions more important, as any slight variation from design would affect the results relatively greater in proportion. In addition, special attention had to be directed to certain thermal and ventilating conditions, as the metabolic rate of the animals had to be considered, as well as the problem of adequate ventilation to overcome the odors of the animals and their excrements. Consequently, the design had to be nice, in the true sense of the word.

For the purpose of design, calculations were based on the occupancy of the room by dogs. It was determined that the average dog required 1600 large calories per 24 hours to maintain static well being. Since the heat input and output must be equivalent for the animal to maintain constant weight, the overall heat emissivity was readily determinable, translating the large calories per 24 hours to Btu per hour, there being 3.969 large calories to the Btu. While the overall heat emission was known, the proportionate quantity of sensible and latent heat was indefinite. Since a dog has essentially no sweat glands, the only latent heat given off is a result of respiration, and consequently the greater part of the heat emission was sensible. All other factors of heat gain were constant, there being a definite quantity of electrical consumption, human occupancy, and conduction.

The total calculated heat gain amounted to 19,790 Btu per hour, of which 7000 Btu represented internal sensible heat. It was decided that a temperature differential of 15F between the room dry bulb temperature and the entering air dry bulb was proper to avoid drafts and also to keep the freon temperature within desirable limits. On this basis a total air delivery of 650 cfm was evolved.

It was felt that the introduction of approximately 150 cfm was adequate for the elimination of odors, and provisions were to be made so that 100% outside air could be introduced if necessary, and a like quantity exhausted.

It was decided that a direct expansion system could satisfactorily be installed if particular emphasis were laid on the automatic control system, and, inasmuch as space was at a premium, an air washer arrangement was considered impractical.

Based on the latent pickup in the room it was necessary to introduce air at a dew point of 34F. To obtain a 34F leaving dew point from the cooling coils, the air leaving the coils was considered to be saturated, and the tonnage was ultimately based on a 34F leaving wet bulb temperature.

On this premise, recalculating the load based on cooling 650 cfm from an entering air condition of 68.1F dry bulb and 55.5F wet bulb (the conditions resulting from mixing 500 cfm of air at 60F dry bulb and 40% relative humidity and 150 cfm of air at 95F dry bulb and 75F wet bulb) to a final condition of 34F wet bulb, the actual heat absorption necessary amounted to 29,700 Btu per hour.

Equipment

The 3 hp Carrier freon condensing unit and the complete air conditioning and exhaust units were located in an adjacent rat room which was stacked high with cages of white mice, guinea pigs, rabbits, and other animals. Since the cages were far from escape-proof, the avoidance of personal contact frequently became a greater problem than the air conditioning installation, and the workmen deserve credit for overcoming this handicap.

Since avoidance of air motion was of primary importance, a draftless type AR Anemostat was employed and centered in the small room. Recirculation was effected at the floor in the corner of the room, cross-connected to the exhaust so that either recirculation or exhaust could be obtained as desired. The general set-up of the air conditioning unit and ductwork is shown in Fig. 2, and indicates the relative size of the conditioning unit.

A separate source of 440 volt current was employed for the operation of the equipment so that, in the event of an enforced blackout, the 110 volt lighting could be disconnected without interfering with the performance of the air conditioning system. To assure a continuous source of steam at all times, connections were made to a high pressure line, and a Boylston reducing valve utilized to obtain 5 lb steam. It was necessary to use a special, hollow stem, dead end reducing valve to accommodate the steam load which varied from practically zero to its maximum capacity.

Cooling and dehumidifying was effected by two sets of Trane direct expansion cooling coils. The first set was six rows deep, and equipped with the standard 96 fins per foot. This coil was designed to cool the air from the original 55.5F wet bulb temperature to a final wet bulb temperature of 41.4F when supplied with 34F freon.

The second coil was eight rows in depth, but, in an effort to avoid excessive frosting and to allow ease in defrosting, was equipped with only 45 fins per foot. This coil was to cool the air from 41.4F wet bulb leaving the first coil to the final conditions of 34F saturated necessary to satisfy the room conditions, with 26F freon.

Since the one coil had to be supplied with 26F freon, the compressor had to be chosen to give the required capacity at that temperature or, more accurately, at a couple of degrees lower suction temperature to allow for pressure drop and oil in the lines.

Inasmuch as frosting was potentially a problem, care had to be taken that this condition was not aggravated. To this end a Hubbell constant back pressure regulating valve was installed on each coil outlet and set at the minimum pressure the respective coil was to operate. Thus, at no time was either coil allowed to operate at a lower suction temperature than that for which it was originally designed. The back pressure regulating valves were also of the compensated type, which allows their setting to be altered (by introduction of air pressure, as described later) as the load varies.

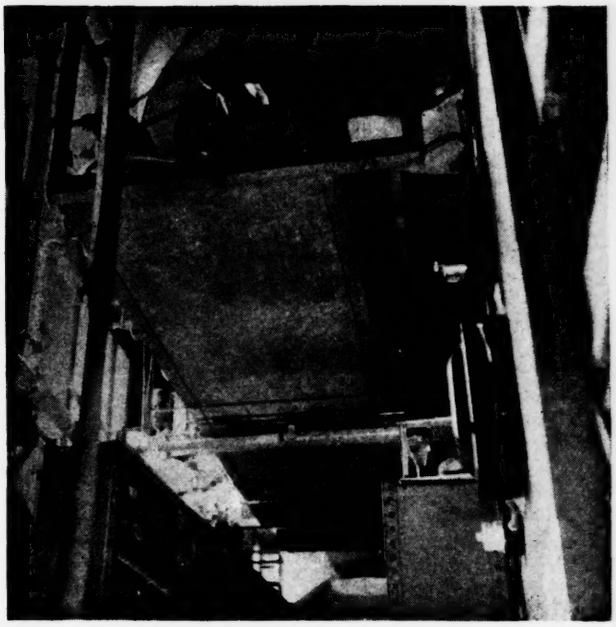


Fig. 3. View showing length of air conditioning unit and location in rat room.

Three sets of Trane fin-type heating coils were installed in the air conditioning unit to effect the necessary reheating for proper humidity control and for the high temperatures frequently required in the space. All the heating coils were inserted after the cooling coils in the direction of air flow, since the full cooling coil capacity would be needed to dehumidify and no tendency to effect sensible cooling from heat derived from any of the heating coils was to be allowed.

The first heating coil in the direction of air flow is of the steam distributing type, primarily designed to accommodate the ventilating load during the winter months. The next two coils are of the standard tube construction and designed to satisfy the balance of sensible heat required as well as to provide the latent heat necessary to vaporize the water for humidification.

A space of approximately 12 in. was allowed between the second and third heating coils for the humidifying sprays. For humidification fine rotary-type nozzles were utilized, half spraying upstream and half downstream, so that both heating coils were sprayed with adequate water. Although only 0.046 gallons per minute were theoretically required for the maximum humidification, a large safety factor was allowed in the installation of the nozzles to allow for imperfect vaporization.

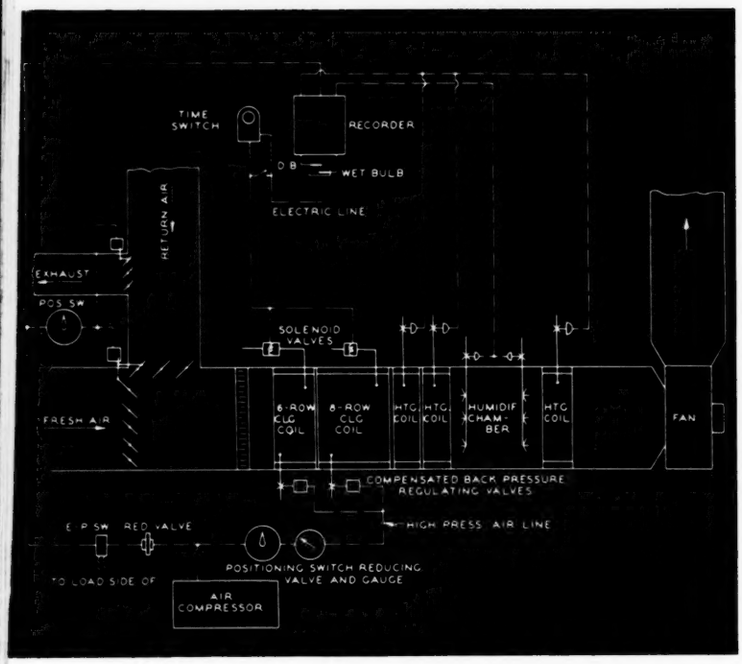


Fig. 4. Schematic diagram showing arrangement of automatic control system and air conditioning unit.

Control System

Inasmuch as proper automatic control was to be the very essence of the installation, considerable thought had to be given to the design. Under any and all conditions the desired temperature and humidity had to be readily obtainable and controlled within the allowable tolerances. Since it was vital that the experimenters could ascertain just what conditions were existent at any time of the day or night, recording instruments were installed.

A Powers pneumatic-type system was employed and the accuracy which was subsequently obtained in the control belies the simplicity of the installation.

A two-pen, 24 hour, recording controller was installed in the conditioned room. One of the elements consisted of a dry bulb recorder and thermostat, and the other a wet bulb. An automatic water pan was installed in the return air duct where sufficient air velocity was present to afford an accurate reading. The recorder was equipped with a wide range adjustable throttling action and automatic reset for sensitive operation.

By referring to Fig. 4 the operation of the control system can readily be observed. The dry bulb thermostat is connected to the three heating coils and so arranged as to modulate a ¼ in. control valve on each heating coil in sequence. Thus, on a temperature drop, the valve on the small, non-freeze coil is modulated open, followed by the second and third coils. Since the capacity of each coil is small, and since modulation can be effected in each coil, extremely fine control results.

The wet bulb thermostat governs the operation of the two banks of spray nozzles only. There, too, the flow is modulated into each bank in sequence. It might appear surprising that modulating action on spray nozzles is attempted, but the amazing accuracy of humidity control indicates that this means of governing humidity is eminently satisfactory.

Control of the cooling and dehumidifying was taken care of by manually setting the refrigerant temperature in the coil by regulating the operation of the compensated back pressure regulating valves. The operator of the system was given a psychrometric chart and instructed how to read it, and how to ascertain the required wet bulb and dew point temperatures, knowing what dry bulb temperature and relative humidity he wanted to maintain. He then had to set the dry bulb and wet bulb thermostats on the recorder to the desired values.

From the control diagram it can be observed that if the temperature of the air (which is essentially saturated) leaving the cooling coils could be controlled so that it is always a fixed amount less than the dew point desired in the room, adequate cooling and dehumidification will result, and any increase in temperature and humidity necessary can be effected by the operation of the heating coils and the humidifier. The difference between the room dew point and the temperature of the air leaving the coils is a function of the latent heat pickup in the room, and since this factor is practically a constant, it was determined that approximately a 2F spread was required; i.e. the dew point of the air entering the room should be not less than 2F lower than the room dew point. Consequently, by adjusting the temperature of the air leaving the coils in accordance with the room dew point, control could be effected. This was accomplished by varying the air pressure from the control system on top of the diaphragm of the back pressure valves, thus raising the suction pressure, and consequently the leaving air temperature.

Due to the fact that the amount of closing of the valves was dependent on the available air pressure, a high pressure line had to be run from the air compressor ahead of the reducing valve. A gradual switch, which is essentially a reducing valve, was installed adjacent to the recorder in the conditioned room, and equipped with a main line and branch line gauge. A chart was supplied to the operator, translating the dew point temperature in the room to the required branch line air pressure to the back pressure valves. Thus, after determining the required wet bulb and dew point temperatures corresponding to the desired room conditions, and setting the dry bulb and wet bulb thermostats, all the operator had to do was to set the positioning switch so as to obtain the branch line pressure corresponding to the dew point noted on the chart.

It was found advisable to raise the refrigerant temperature at such times that a high dew point was required in the room to avoid too great a cycling of the re-humidification. In a fine control installation of this type it was also deemed necessary to allow the compressor to run continuously, as intermittent operation would cause much too great a fluctuation. At such times that high dew points were required in the space, the compressor was stopped manually.

The operation of the outside air, return air, and exhaust air dampers was effected by means of the conventional positioning switch.

Whatever the space operated at dew points below 45F, the refrigerant temperature was low enough to cause frosting. Because a short period of increased temperature and humidity did not affect the performance of the experiments being conducted, an automatic time switch was installed to allow a five minute defrosting cycle every 1½ hours. This defrosting cycle adequately took care of all frosting tendencies. A manual switch was installed in parallel with the time switch so that the operation of the time switch could be obviated when operating above the frost point.

Operation

The author would like very much to report that, upon completion of the installation, a switch was thrown, and the system immediately began to operate in exact accordance with the calculations. Actually, it was found necessary to make quite extensive tests and adjustments before satisfactory operation resulted. Because adjustments of this type undoubtedly are necessary following the completion of such installations, it is thought that a resume of those vital checks be mentioned and the following suggestions are made as important follow-ups.

1. A test of air quantities should be performed before any other investigation is made, inasmuch as any quantity of air delivery other than that for which the system is designed will influence the results quite materially. If too large a quantity of air is delivered, high face velocities through the cooling coils will cause an increase in the sensible heat absorption, and a decrease in the latent heat absorption, causing the air leaving the coil to have too high a dew point. Naturally this will result in inability to maintain a relative humidity in the room as desired. If the air quantity is below specifications, it might be impossible to obtain the desired dry bulb, as well as wet bulb, within the conditioned space, and the overall heat absorption will be reduced. Consequently, it is important that careful tests be made and adjustments performed in order that the air delivery be as close to the theoretical design as possible. Fortunately, this correction can be made quite simply by means of a variable pitch pulley on the fan motor.

2. Where such low leaving air temperatures are required, it is vital that the refrigerant temperatures be kept as low as possible, and to this end the author recommends that the designing engineer place not too much dependence on capacity tables of expansion valves. The proper selection of the thermal expansion valve is of great importance. Naturally the valve cannot be too small or decreased capacity will result. But an oversized valve might also cause trouble, as serious cycling might result, causing a decrease in the overall capacity of the coil. The author recommends that, upon completion of an installation of this type, accurate temperature readings, by means of a thermocouple, be made at the liquid and suction headers of the cooling coils. If the temperature at the suction headers fluctuates more than a total of ten degrees, it is quite likely that cycling is occurring as a result of an oversized expansion valve, and a smaller one should promptly be installed.

It is advisable that a superheat of the refrigerant be maintained as low as possible and, to determine this, a thermocouple is invaluable. Care must be exerted in adjusting an expansion valve to a low superheat that flooding of liquid does not occur, as this, also, will decrease the efficiency of the system. Flooding can be readily determined by a cold compressor crank case and foaming of the oil in the crank case.

3. Where mechanical compliance with theoretical design conditions is necessary, any ineptitude in installation becomes serious, possibly even critical. Inexpert assembling of the conditioning unit, particularly at the inlet side of the fan, can easily upset design calculation. It is recommended that all ductwork and the air conditioning unit be made as airtight as mechanically possible. All joints should be

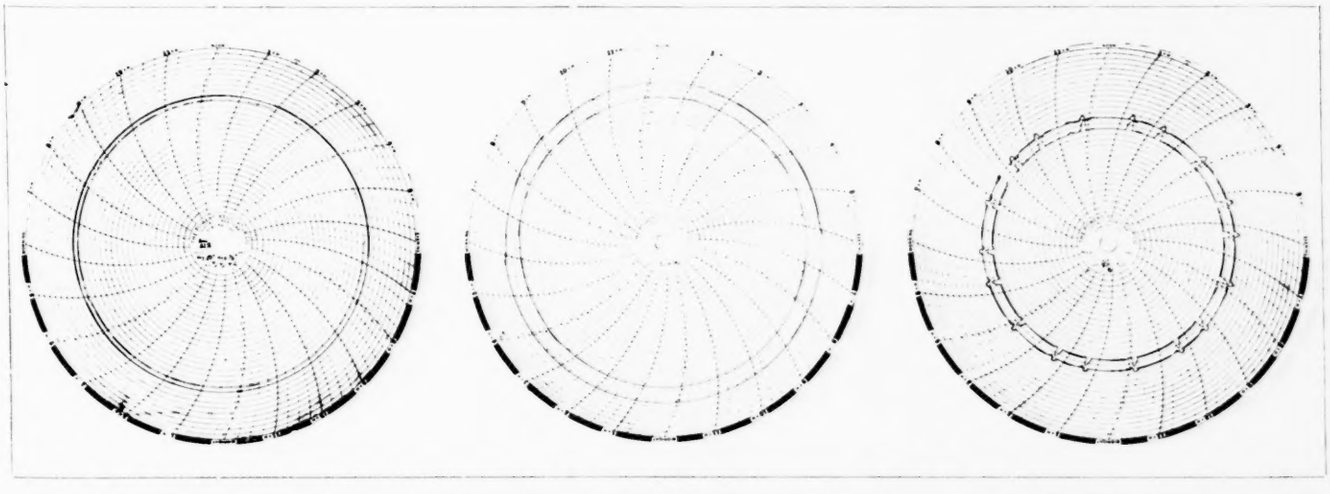


Fig. 5. Dry bulb and wet bulb temperature charts, showing operation of system. Left, chart showing control when system was cooling and dehumidifying; center, operation of system while heating and humidifying to slight degree; right, chart showing reaction of room conditions with defrosting cycle in operation while cooling and dehumidifying.

thoroughly caulked, and soldered if possible, to prevent infiltration of air around the cooling and heating coils. Where pipes extend through the casing, sponge rubber inserts should be employed. All access doors should be equipped with rubber gaskets and window type latches to allow air-tight closing. Safing around the coils is imperative and all safing should be finished with some type of sealing compound to prevent air by-passing around the coils. Where it is obligatory to install the supply blower outside the air conditioning casing, an extra heavy weight canvas connection should be used, and then finished off with several coats of lacquer. It is surprising how much air can leak through canvas. When the fan is outside the casing, the seal at the drive side of the fan should be carefully checked to make certain it is air-tight, as leakage at the seal might be quite serious. No by-pass dampers should be installed at any point where the air might have an opportunity of circumventing the cooling coils, as the best constructed damper will leak sufficient air to affect the operation seriously.

4. Where heating coils are placed adjacent to cooling coils, a space should be allowed between the two coils. If there is no space, actual conduction of heat from the heating coil to the cooling coil might result. This heat transmission causes a boiling of some refrigerant, and accomplishes no thermal good whatsoever, but merely decreases the efficiency of performance.

5. Where a wet bulb controller is employed, it must be borne in mind that a 1F variation in wet bulb temperature, assuming a constant dry bulb temperature, might result in as much as a 5% variation in relative humidity. Consequently, fine control of the wet bulb temperature is of utmost importance.

Upon the meticulous completion of all the adjustments in this particular installation, the performance was most gratifying, and the actual results exceeded the stipulated design conditions. The author was frankly surprised to learn of the fine control which could be accomplished by a direct-expansion system of this type.

This article can not be completed without an expression of appreciation for the fine and intelligent cooperation of the medical staff of Northwestern University. It is hoped that the air conditioning installation will be a valuable contribution in the advancement of medical science. More selfishly, it is also possible that a new field of operation might be open to the air conditioning industry in the never-ending struggle against the diseases of man.

Fighting Plane Radio Parts

are tested in a controlled atmosphere room from +158F to —40F to simulate Arctic and tropical conditions. The radio parts are tested over this range every 10F.

Temperature and humidity conditions ranging from those of steaming tropical jungles to those at the Arctic Circle are simulated in the cold room of an aircraft accessories company in the mid-west where much of the radio equipment is produced for Uncle Sam's fighting planes.

The company manufactures precision radio parts for special equipment as well as receiving and transmitting sets for Army and Navy planes, delicate detector instruments for anti-aircraft use, and sound detection instruments for the Navy for detecting the presence of submarines and hostile craft. Since all equipment will serve under many conditions and must stand up at high and low temperatures with equal efficiency, it has been necessary to construct a room in which temperatures from + 158F to — 40F can be achieved rapidly enough to test and approve equipment as it comes off mass-production lines.

Solution to the problem is the cold room, an 8 by 12 foot space lined with 8 in. of cork insulation in walls and floor, 10 in. in the ceiling. A 50 hp. refrigeration compressor is installed in the center roof panel of the room. A boiler and humidifier to produce the high humidity needed to simulate Caribbean conditions are likewise used, with a battery of electric strip heaters to produce above 150F in a few moments' time.

The compressor is a dual-capacity type normally using 25 hp. for low loads, and switching to the maximum when lowest temperatures are desired. The strip heaters are mounted above shoulder height on the cold room walls and circulate heated air transversely over the test shelves.

Equipment undergoing the test is put through the full range of temperatures and checked every ten degrees for operating efficiency, and has included radio equipment ranging from a large transmitter the size of a refrigerator down to microscopically small electrical parts. Rubber-gasket pneumatic seals are used on the double-door entrance through which all test equipment moves, and seal the room effectively against cold or heat leakage. Period of test varies with the type of equipment being checked, ranging from an hour for some materials to eight hours for vastly important two-way sets for stratosphere bomber and fighter plane sets. Use of the cold room has developed several improvements in aerial radio manufacture.

DEGREE-DAYS FOR DECEMBER, 1942

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days			Year[1]
	Degree-Days, Dec., 1942	Degree-Days, Dec., 1941	Degree-Days, Dec., Normal	Season, 9/1/42-12/31/42	Season, 9/1/41-12/31/41	Season, Normal 9/1-12/31	Normal, 9/1-6/30
Abilene, Texas	535	486	592	900	880	925	2061
Albany, New York	1313	1097	1147	2704	2343	2439	6580
Albuquerque, New Mexico	749	846	924	1497	1743	1827	4298
Alpena, Michigan	1303	1081	1247	2958	2527	2951	8299*
Anaconda, Montana	1129	1271	1238	3064	3371	3171	8357**
Asheville, North Carolina	820	690	837	1656	1379	1689	4232
Atlanta, Georgia	670	531	639	1123	948	1131	2890
Atlantic City, New Jersey	927	741	893	1617	1356	1735	5176
Augusta, Georgia	540	441	549	832	733	886	2161
Baker, Oregon	1098	1032	1156	2645	2790	2815	7163
Baltimore, Maryland	928	698	874	1611	1213	1664	4533
Billings, Montana	1082	1137	1194	2658	2822	2816	7119
Binghamton, New York	1244	998	1156	2524	2099	2515	6808
Birmingham, Alabama	568	472	595	942	851	913	2352
Bismarck, North Dakota	1623	1280	1553	3584	3136	3514	9192
Block Island, Rhode Island	1031	836	884	1979	1667	1736	5788
Boise, Idaho	979	930	1011	2245	2275	2285	5552
Boston, Massachusetts	1132	923	1026	2169	1822	2130	6045
Bozeman, Montana	1150	1319	1293	3052	3387	3286	8521**
Buffalo, New York	1233	966	1104	2493	2061	2372	6822
Burlington, Vermont	1424	1214	1287	2998	2747	2773	7514
Butte, Montana	1221	1359	1261	3369	3681	3183	8272
Cairo, Illinois	853	686	822	1481	1300	1499	3909
Canton, New York	1475	1276	1342	3042	2826	2994	8020
Charles City, Iowa	1503	1098	1390	3102	2431	2895	7588
Charleston, South Carolina	455	333	425	638	508	632	1769
Charlotte, North Carolina	729	556	679	1216	975	1220	3120
Chattanooga, Tennessee	722	649	694	1347	1234	1225	3118
Cheyenne, Wyoming	1031	1089	1144	2776	2830	2889	7466
Chicago, Illinois	1307	889	1119	2592	1859	1919	5957
Cincinnati, Ohio	1046	794	927	1984	1549	1796	4684
Cleveland, Ohio	1134	826	1060	2200	1784	2185	6155
Columbia, Missouri	1043	788	985	1957	1594	1896	4922
Columbia, South Carolina	593	458	561	910	750	916	2364
Columbus, Ohio	1109	833	1017	2095	1667	2020	5398
Concord, New Hampshire	1352	1137	1234	2860	2623	2732	7353
Concordia, Kansas	1130	897	1050	2189	1878	2019	5315
Dallas, Texas	530	476	567	863	858	870	2256
Davenport, Iowa	1316	928	1175	2541	1918	2333	6289
Dayton, Ohio	1105	826	1014	2099	1690	1947	5264
Denver, Colorado	867	932	1017	2100	2179	2276	5874
Des Moines, Iowa	1314	986	1215	2563	2043	2370	6384
Detroit, Michigan	1223	912	1113	2493	1963	2332	6490
Devils Lake, North Dakota	1829	1406	1710	3922	3538	3871	9970
Dodge City, Kansas	1016	856	1004	1993	1768	1952	5035
Dubuque, Iowa	1379	1011	1243	2758	2097	2534	6790
Duluth, Minnesota	1633	1319	1519	3654	3169	3489	9443
Eastport, Maine	1353	1138	1228	2932	2735	2890	8520**
Elkins, West Virginia	1051	832	1035	2162	1872	2217	5697
El Paso, Texas	537	524	617	829	945	1038	2428
Ely, Nevada	1047	1131	—	2848	3171	—	—
Erie, Pennsylvania	1138	866	1039	2238	1809	2164	6273
Escanaba, Michigan	1412	1127	1344	3199	2692	3138	8771*
Evansville, Indiana	995	779	862	1876	1550	1545	4244
Fort Smith, Arkansas	685	603	707	1184	1120	1177	3147
Fort Wayne, Indiana	1294	947	1138	2551	2032	2211	5925
Fort Worth, Texas	545	464	574	857	852	826	2148
Fresno, California	594	495	577	1042	951	911	2334
Galveston, Texas	220	217	270	304	381	330	1016
Grand Junction, Colorado	940	935	1162	1966	2159	2278	5548
Grand Rapids, Michigan	1195	909	1147	2492	1989	2397	6535
Green Bay, Wisconsin	1438	1083	1324	3023	2404	2882	7825
Greensboro, North Carolina	846	666	760	1545	1283	1395	3529
Greenville, South Carolina	724	560	738	1223	972	1334	3380
Harrisburg, Pennsylvania	1067	852	992	2046	1675	1981	5357
Hartford, Connecticut	1200	986	1060	2347	2029	2157	6036
Hatteras, North Carolina	539	404	493	767	641	727	2571
Havre, Montana	1386	1276	1383	3250	3082	3314	8700
Helena, Montana	1155	1256	1245	3027	3276	3058	7898
Houston, Texas	270	243	335	416	450	449	1157
Huron, South Dakota	1506	1153	1431	3245	2651	3085	8004
Indianapolis, Indiana	1140	822	1017	2121	1617	2002	5298
Ithaca, New York	1235	1008	1125	2533	2158	2450	6719
Kansas City, Missouri	1059	778	1008	1966	1564	1866	4956
Kewanee, Illinois	1358	913	1118	2695	1865	2311	6139
Knoxville, Tennessee	809	610	781	1469	1198	1483	3670
La Crosse, Wisconsin	1453	1091	1311	2983	2353	2778	7322
Lander, Wyoming	1162	1232	1419	3083	3212	3075	7947

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.: Norman E. Ross, Bursar, Bates College, Lewiston, Me.: J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively: Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

(a) Data not yet available.

[Table Concluded on Page 78

Degree-Days for December, 1942 (Concluded)

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days			Year[1]
	Degree-Days, Dec., 1942	Degree-Days, Dec., 1941	Degree-Days, Dec., Normal	Season, 9/1/42-12/31/42	Season, 9/1/41-12/31/41	Season, Normal 9/1-12/31	Normal, 9/1-6/30
Lansing, Michigan	1280	950	1209	2746	2158	2665	7048
Lewiston, Maine	1346	1171	1295	2946	2758	2837	7707
Lincoln, Nebraska	1225	967	1132	2391	2036	2201	5999
Little Rock, Arkansas	679	596	651	1184	1089	1079	2811
Livingston, Montana	1015	1130	1117	2785	2968	2731	7205
Los Angeles, California	209	254	301	354	403	424	1504
Louisville, Kentucky	960	713	849	1758	1371	1587	4180
Lynchburg, Virginia	865	647	800	1539	1224	1557	3980
Macon, Georgia	518	445	567	847	801	897	2201
Madison, Wisconsin	1454	1071	1321	2944	2284	2758	7429
Marquette, Michigan	1379	1120	1302	3172	2740	3054	8693*
Memphis, Tennessee	704	615	663	1175	1178	1127	2950
Meridian, Mississippi	491	448	549	829	842	883	2160
Milwaukee, Wisconsin	1391	1011	1221	2865	2255	2601	7245
Minneapolis, Minnesota	1535	1203	1404	3218	2634	2941	7850
Modena, Utah	964	1054	1168	2382	2735	2672	6562
Montgomery, Alabama	446	396	496	713	674	769	1884
Nantucket, Massachusetts	1016	839	905	1975	1722	1912	5957
Nashville, Tennessee	791	608	744	1391	1174	1363	3507
New Haven, Connecticut	1130	898	1017	2131	1760	2109	5895
New Orleans, Louisiana	255	211	301	378	389	403	1024
New York, New York	1034	834	955	1844	1532	1849	5347
Nome, Alaska‡	1570	1391	1509	3276	2973	3379	14580**
Norfolk, Virginia	701	547	685	1097	890	1195	3350
Northfield, Vermont	1473	1276	1395	3206	2975	3254	8719*
North Head, Washington	633	693	654	1711	1572	1785	5452**
North Platte, Nebraska	1049	1054	1173	2424	2311	2486	6366
Oakland, California	481	428	496	1089	971	1099	3143**
Oklahoma City, Oklahoma	753	643	815	1358	1244	1379	3613
Omaha, Nebraska	1264	995	1175	2485	2128	2284	6131
Oswego, New York	1266	1050	1138	2540	2230	2494	7088
Parkersburg, West Virginia	1016	771	921	1903	1571	1830	4775
Peoria, Illinois	1255	886	1150	2469	1845	2323	6109
Philadelphia, Pennsylvania	1000	779	905	1760	1392	1735	4855
Phoenix, Arizona	281	335	425	376	488	581	1405
Pittsburgh, Pennsylvania	1054	796	967	2003	1622	1949	5235
Pocatello, Idaho	1078	1091	1181	2546	2893	2649	6655
Portland, Maine	1297	1103	1263	2856	2591	2795	7218
Portland, Oregon	645	658	729	1488	1512	1724	4469
Providence, Rhode Island	1126	945	1026	2142	1870	2139	6015
Pueblo, Colorado	909	1007	1029	2084	2239	2164	5514
Raleigh, North Carolina	744	583	694	1252	988	1253	3234
Rapid City, South Dakota	1149	1045	1172	2781	2555	2701	7118
Reading, Pennsylvania	1070	842	1001	1995	1612	2014	5389
Redding, California	615	572	570	1054	977	919	2451
Reno, Nevada	878	861	973	2129	2173	2284	5892
Richmond, Virginia	837	657	763	1449	1177	1380	3695
Rochester, New York	1260	1029	1125	2575	2204	2414	6732
Roseburg, Oregon	611	649	719	1424	1559	1741	4428
Roswell, New Mexico	612	681	808	1193	1331	1510	3484
Sacramento, California	588	490	574	1010	912	996	2653
St. Joseph, Missouri	1138	840	1079	2142	1743	1960	5161
St. Louis, Missouri	982	735	936	1787	1440	1738	4585
Salt Lake City, Utah	984	889	1020	2209	2171	2149	5555
San Antonio, Texas	314	316	347	506	537	473	1202
San Diego, California	236	232	288	389	350	487	1645
Sandusky, Ohio	1187	855	1063	2286	1790	2142	6208
San Francisco, California	399	360	428	959	789	949	3264**
Sault Ste. Marie, Michigan	1515	1277	1370	3445	3090	3247	9285**
Savannah, Georgia	388	289	397	545	428	598	1490
Scranton, Pennsylvania	1190	951	1085	2361	1967	2274	6129
Seattle, Washington	638	651	719	1630	1632	1869	4934**
Sheridan, Wyoming	1104	1232	1320	2818	3028	3198	8008
Shreveport, Louisiana	524	451	499	809	844	769	1938
Sioux City, Iowa	1397	1114	1265	2882	2390	2583	6898
Spokane, Washington	1011	971	1057	2483	2542	2583	6355
Springfield, Illinois	1150	816	1039	2157	1655	2002	5373
Springfield, Missouri	904	798	893	1779	1616	1674	4428
Syracuse, New York	1282	1053	1172	2600	2234	2491	6893
Tacoma, Washington	664	706	756	1754	1796	1951	5181**
Terre Haute, Indiana	1105	805	992	2055	1589	1840	4872
Toledo, Ohio	1224	890	1079	2419	1892	2189	6077
Topeka, Kansas	1071	807	1008	1982	1642	1883	4969
Trenton, New Jersey	1066	841	930	1947	1589	1760	4933
Utica, New York	1310	1082	1144	2728	2360	2537	6796
Valentine, Nebraska	1172	1092	1245	2778	2546	2725	7039
Walla Walla, Washington	810	776	896	1801	1837	1909	4808
Washington, D. C.	937	715	896	1653	1306	1741	4626
Wichita, Kansas	1006	783	955	1877	1631	1783	4673
Williston, North Dakota	1564	1254	1591	3578	3200	3658	9323
Winnemucca, Nevada	973	935	1080	2297	2455	2589	6427**
Yakima, Washington	1082	915	1091	2297	2178	2428	5599

‡Nome data are for November.
*Includes August. **Includes July and August.
[1]Figures in this column are normal totals for a complete heating season, September to June, incl. (a) Data not yet available.

WASHINGTON NEWS

Summarized by Loring F. Overman. WPB and PAW Positions Clarified Relief Seen in Fuel Oil Situation Priorities Raised on A. C. Repairs.

Despite the fact that Washington itself was experiencing one of the mildest winters in years, the Capitol City has had plenty of reason to recall that heating and air-conditioning is a subject too important to be taken for granted.

On two occasions during January Washington's thermometers hovered near the 70F mark, but the mercury was near the boiling point in the Office of the Petroleum Administrator for War, the Office of Defense Transportation, and in the War Production Board industry divisions charged with the responsibility of deciding what is and what is not essential to the war effort.

Nor should the problems of the Office of Price Administration be overlooked, for they added up to the resignation of Price Administrator Leon Henderson, into whose thankless office moved former Senator Prentiss M. Brown.

Mid-January brought a clarification of the position of WPB and the office of the Petroleum Administrator for War. Executive Order 9276, delegated to Harold Ickes authority to determine policies and take actions relating to the industry.

1. The Administrator will issue directives and orders to the petroleum industry relating to the production, refining, treating, storage, shipment, receipt and distribution within the industry of petroleum, petroleum products, or associated hydrocarbons as defined in the order. To avoid confusion with WPB actions, the Administrator's actions will be designated as "petroleum directives" or "petroleum Administrative orders."

2. The Administrator may also take action, to the extent specified in the order, concerning the distribution within the industry of other products or materials, including the granting or denial of priority, allocation, or preference rating assistance to the industry. Such actions will be subject to program determination and other directions of the WPB chairman and will be issued in the name of WPB's Director General for Operations. The Administrator's signature will appear on such documents so that the industry will be able to distinguish between actions originating in WPB and those originating in PAW.

3. The Administrator will give WPB reasonable advance notice and opportunity for consultation before taking any of the actions outlined above, excepting in case of an emergency, by mutual agreement with certain WPB officers, or in cases where the proposed action will not affect more than two members of the industry, provided the members do not represent the majority of the particular branch of the industry affected.

4. WPB will continue to give the Office of Petroleum Coordinator for War reasonable notice and opportunity to be heard concerning all actions which might affect the petroleum industry, subject to the same exceptions set forth above.

5. The Administrator will give WPB five days' notice before taking action affecting products or hydrocarbons not deemed to come within the definition of the Executive Order.

6. The Administrator will provide the means for enforcing all "petroleum directives."

7. As soon as possible, WPB orders which come within the provisions of paragraph 1 above will be reissued by the Administrator, and the WPB orders will be revoked. This includes L-70, regulating shipments of motor fuel, and all orders in the M-68 series, which deal with petroleum production and marketing material and conservation of petroleum material.

"As Soon as Possible"

"As soon as possible" after having his position clarified, Administrator Ickes et al, while struggling through a settlement of the anthracite coal mine strike, tackled the multi-faceted task of increasing production and shipments on one hand, and limiting consumption on the other.

Elimination of pleasure driving in the 17 Eastern states was an early step. Tighter control over use of fuel oil for non-heating purposes by commercial, industrial and government consumers was another, added to such previous steps as a 10% reduction in the value of all fuel ration coupons, a 25% reduction in fuel oil rations to commercial buildings, and a 25% cut in the value of "A," "B" and "C" gasoline coupons.

15% Boost Possible

That the combined program may soon result in relief was indicated on January 26 when the Senate fuel oil and gasoline investigating committee was told by John J. Pelley, president of the Association of American Railroads, that a 15% increase in oil shipments to the East Coast is expected in the next 30 days.

The four factors he outlined were:

(1) A 20,000 barrel daily increase through shipping in steel drums in box cars;

(2) Added unloading facilities, resulting in a 25,000 barrel per day increase;

(3) Additional tank cars in the Eastern service, responsible for 20,000 more barrels daily; and

(4) Additional pipeline movement of 43,000 barrels per day from the Norris City (Ill.) terminal.

These are responsible, Mr. Pelley said, for an additional 108,000 barrels of fuel oil daily being received on the East Coast over the 770,000 barrels averaged daily for the past 11 weeks.

"I feel confident this total can be increased to 900,000 barrels a day in the next 30 days, and these figures are conservative," Mr. Pelley told inquisitive Senators.

500,000 Drums Authorized

WPB has arranged for the construction of 500,000 steel drums with a total capacity of 600,000 barrels. The drums are to be delivered to railroads in a few days, it was stated, and 500,000 additional drums can be built quickly if it appears that flat car facilities are available to handle them. Approximately 200,000 drums have been loaned to railroads by the Army and are now carrying kerosene to New England.

Locomotive power is a limiting factor on the capacity of railroads to transport oil and the industry would like to receive 1,000 new locomotives this year. "It is unlikely, however, that we will receive more than 600," Mr. Pelley said.

R. L. Minckler, director of supplies in the office of the Petroleum Administrator for War, told Senators the East Coast oil problem is still serious.

"With careful and close management of oil supplies, however, we

should be able to avoid hardships and suffering, if not inconvenience, on the part of consumers," Mr. Minckler said. "Improved transportation prospects, plus reductions made in consumption, barring unforseen bad weather and unexpected military demand, will help keep people moderately warm."

Senators attending the hearing were told that January 26 brought WPB approval to Petroleum Administrator's proposed second pipeline from Beaumont, Tex., to Seymour, Ind. The 20-inch line to carry petroleum approximately 830 miles nearer the east coast will have a capacity of 235,000 barrels daily when completed. It was estimated that by instituting a shortened shuttle system of tank cars from the terminus of the line to the coast, the Atlantic seaboard will benefit by 110,000 barrels a day.

P&H Division Active

With one group of government executives working on the problem of producing and transporting more oil, and another limiting consumption, Director Joseph F. Wilber's Plumbing and Heating Division of WPB wrestled with means of making a limited amount of raw materials produce the best results in new equipment and in upkeep.

Personnel changes accompanied the program. Vincent Manas, who compiled many of the construction standards adopted by NHA, took over as chief of the plumbing section, succeeding Chester Wilcox, resigned. William F. Bilyew became acting chief of the heating sections, occupying a position vacated by the resignation of Lewis Smith.

I. Q. Lord remains as chief of the new program section; John P. Kelly is chief of the inquiries and distributors' section, and Ronald Allwork is deputy chief of the Division.

The Division is taking a leading role in facilitating conversion and the development of auxiliary heating units. January accomplishments at the Division included an amendment (January 26) to Limitation Order L-187, Low Pressure Cast Iron Boilers; an interpretation of Limitation Order L-185, regulating the production of water heaters, and issuance (January 23) of Limitation Order L-252, reducing from 4,079 to 2,504 the number of types of gate, angle, cross and check valves now produced.

Under L-252, effective January 23, valves are classified by design, by materials used, by pressure and by size. The complete elimination of cross valves and of brass or iron angle check valves will reduce permitted designs. Pressure classes will be reduced from 18 to 12, and under the order, valves will be produced in fewer sizes.

Because many of the valves used on ships must meet special conditions, they are not covered by the order. Valves ordered for ship construction approximate 45% of those produced.

Regardless of the pressure class, brass valves may be manufactured only in sizes of two inches or less. Union bonnet rings and stuffing box packing nuts for brass valves are to be made of malleable iron or steel.

Steel valves in pressure classes of 150, 600, 900 and 1,500 lb are to follow specifications set by the American Standards Association or the American Petroleum Institute. For each pressure class, the order covers end flange faces, the materials for bodies and bonnets, seating materials for stems, bonnet bolting and bonnet bolt nuts. On valves of five inches or larger, the disc is to be of the same material as the body of the valve.

Iron valves of five pressure classes, from 25 lb per sq in to 300 lb, and of 29 sizes from ¼ in to 72 in., are permitted under the order. On all types, end flanges are to conform to existing standards. Materials are specified for seating parts, bonnet bolts or studs, bonnet bolting and handwheels. There are separate specifications for gate valves, for globe, angle, cross valves and for check valves.

Complete copies of Limitation Order L-252, as well as all other priorities data, may be secured by writing the War Production Board, or the U. S. Information Center, Washington, D. C.

A.C. Repair Ratings Upped

Higher preference ratings are assigned for the emergency repair of refrigerating and air-conditioning systems used for specified purposes under the terms of Preference Rating Order P-126 as amended, the Director General for Operations has announced.

The amendment is a comprehensive revision of the original order controlling delivery of material for emergency repair servicing of industrial and commercial refrigerating and air-conditioning systems. It restates the three classifications of users of refrigerating and air-conditioning systems entitled to priority ratings under the order, and raises the ratings for replacement parts needed by users in the first class from A-1-a to AA-2X; those in the second class from A-3 to AA-3 and the third class from A-8 to AA-4.

Whenever a rating of AA-2X is applied to delivery to users in the first class, the service agency applying the rating must notify the War Production Board promptly by telegram or letter explaining the circumstances requiring the application of such rating, stating the material obtained and naming the supplier.

Comfort cooling systems, as defined in the order, of any size operated for the purpose of lowering the temperature or humidity of air in any building, room or other enclosure are not provided for by any ratings. The order lists the types of use included within the definition of "Comfort Cooling Systems." It excluded from the definition, however, such parts of comfort cooling systems as may be required for the circulation of air or for raising the temperature during cold weather to a degree which is comfortable or tolerable for persons.

Emergency service agencies cannot deliver any metallic replacement parts unless the owner of the system turns in the old part immediately upon installation of the new in order that such old parts may be repaired, re-conditioned or disposed of to a scrap dealer.

None of the provisions of the amended order applies to domestic mechanical or ice refrigerators.

The term "emergency service agency" as defined in the amended order covers any person engaged in performing repair services and holding an "emergency service agency certificate" issued by WPB.

War Housing Standards

A revision of war housing construction standards, easing in some respects the restrictions on design and material consumption, was announced January 23 by the WPB and the National Housing Agency. The standards were originally established October 28, 1942. The principal changes, which are of principal interest to private builders, included:

Increase of 10-15% in permitted floor area;

Removal of ban on use of softwood lumber for finishing and sub-flooring;

Expansion of areas in which wood frame construction may be used;

Elimination of heating provisions, since the major requirements formerly included have been incorporated in the current war housing Critical List.

In prescribing the maximum floor areas for dwelling units of various sizes in the original standards, WPB and NHA officials acted to insure that the maximum number of such units would be produced from the limited visible supply of critical material. In increasing the floor areas, the revised standards will make it easier for builders to operate within the restrictions imposed on war housing construction, and better—planned, more liveable homes are expected to result.

JANUARY WASHINGTON NEWS HIGHLIGHTS

Editor's Note: Supplementing its regular summary of Washington News, Heating and Ventilating will publish a monthly index to press releases and other government—issued material of particular interest to those affiliated with heating, ventilating and air conditioning industries. Copies of releases or publications listed may be secured by writing U. S. Information Center, 1400 Pennsylvania Avenue, Washington, D. C. January releases follow, with the date of release preceding each. The number following each item is the release number.

26th—To Ration Fuel Oil in Northwest. Petroleum Administration for War. The rationing of heating oil in the Pacific Northwest was directed today by the Petroleum Administrator for War in a move designed to reduce domestic consumption in the states of Washington and Oregon approximately 25 per cent.

26th—Fuel Oil Rationing Order Amended. Office of Price Administration. Emergency procedure which will enable oil rationed householders to acquire up to 50 gallons of fuel oil in a minimum of time was provided today by Amendment 30 to RO-11, effective Feb. 1.

25th—Eastern Fuel Situation Still Acute. Solid Fuels Coordinator for War. Even with increased production of hard and soft coal reported during the week ending Jan. 16, and emergency distribution measures instituted, the East Coast fuel situation remains acute, Coordinator Ickes said.

24th—Nelson Asks Cut in Gas Use. War Production Board. Donald Nelson, WPB chairman, today urged residential users in western, southern New York, northern Pennsylvania, to reduce consumption of natural and mixed natural gas by 25 per cent during next 10 weeks.

23rd—War Housing Building Standards Revised. War Production Board—National Housing Agency. Joint announcement by WPB and NHA on revision of war housing construction standards eases some design and material consumption restrictions.

23rd—Valve Models Simplified by L-252. War Production Board. Number of gate, globe, angle, cross, check valve types now made reduced from 4,079 to 2,504 by Limitation Order L-252, issued and effective today.

22nd—Oil Ration Coupons Advanced. Office of Price Administration. OPA today advanced by one week date when number 4 fuel oil ration coupons may be used and rescinded recent 10% increase in allotments in Kentucky and parts of five Middle Western states where winter has been milder than normal.

21st—Petroleum Production Rate Lifted. Petroleum Administration for War. Petroleum Administrator Ickes today announced production rate of 4,162,300 barrels daily of all petroleum liquids had been certified to petroleum-producing States for February, 1943, an increase over January of 38,100 barrels.

21st—Q. & A. on Oil Burner Conversions. War Production Board. Questions and answers were issued today by Plumbing and Heating Division of WPB to clarify some problems which have arisen in connection with conversion of fuel oil burners to coal.

21st—Steam Under Service Rule. Office of Price Administration. Supplying of steam, except by public utilities, was transferred today by OPA from price control under the General Maximum Price Regulation to Services Regulation by Amendment 16 to SR-165, effective Jan. 27.

20th—$1,214,850,897 in Construction Stopped. War Production Board. Construction projects having total cost of $1,214,850,897 have been stopped during last twelve weeks in line with policy of curtailing non-war work to free materials, equipment and other resources for more essential uses, WPB announced today.

20th—OPA Order Issued in 40% Oil Cut. Office of Price Administration. OPA amendment 29 to Ration Order 11, accompanying action of PAW reducing by 40% oil ration of certain commercial, industrial, and governmental consumers for non-heating purposes in 17 eastern states District of Columbia, issued and effective today.

18th—Fuel Oil Control Tightened. Office of Price Administration. Tighter control over use of fuel oil for non-heating purposes by commercial, industrial, and Governmental consumers in 17 East Coast States and District of Columbia resulted today from joint action taken by Petroleum Administrator Ickes and Acting Price Administrator John Hamm.

12th—Soft Coal Price Revisions in Plan. Bituminous Coal Division. Bituminous Coal Division has instituted a proceeding for making such revisions in minimum soft coal prices as may be found necessary under provisions of Bituminous Coal Act, Secretary Ickes announced today.

12th—Defense Supplies to Aid in Fuel Crisis. Department of Commerce. Defense Supplies Corp. will absorb extraordinary costs of moving kerosene into North Atlantic States by shipping it in drums, Secretary Jones announced today. This program, recommended by PAW and OPA, undertaken to alleviate critical shortage of heating materials.

11th—War Housing Priority of AA-3 Set. War Production Board. Blanket preference rating of AA-3 assigned today by WPB to deliveries of materials for use in construction of most war housing projects programmed by NHA.

11th—Order on Water Heating Clarified. War Production Board. Interpretation 1 of Order L-185 is issued explaining that any heating appliances, including laundry stoves or laundry heaters, which have built-in coils for water heating, or which have water jackets as integral parts of the appliances are water heaters.

9th—East Coast Oil Inventories Still Low. Petroleum Administration for War. The drop in petroleum inventories which has characterized the East Coast oil situation during the last three weeks was checked slightly during the week ended Jan. 2, 1943, but withdrawals still run ahead of receipts, leaving East Coast oil stocks close to minimum safe working levels, Petroleum Administrator for War Ickes reported today.

9th—Ickes Calls Coal Stoppage "Intolerable." Office of Solid Fuels Coordinator for War. Terming the present stoppage of production in the anthracite coal fields "intolerable," Solid Fuels Coordinator for War Harold L. Ickes today called on the industry to "produce this coal" and not offer "declarations of indeterminate intent."

9th—Primary Fuel Oil Supplier Defined. Office of Price Administration. The definition of a primary fuel oil supplier, as used in rationing regulations, was revised by the OPA to simplify the control of fuel oil transfers across the rationing border. Under the new definition, a "primary supplier" is, with two exceptions, the first person in point of time who has possession of fuel oil within the limitation area, other than a carrier. These modifications are contained in Amendment 22 to the fuel oil rationing regulations, effective Jan. 15, 1943.

8th—Fuel Oil Dealer Must Honor Coupons. Office of Price Administration. Every fuel oil dealer must honor fuel oil rationing coupons as long as he has oil in stock, Administrator Henderson announced today.

7th—500 Petroleum Tanks Authorized. War Production Board. Production of 500 additional semi-trailer petroleum tanks to help relieve oil transportation shortage provided for under Limitation Order L-I-G as amended and issued today.

7th—20% Cut in Fuel Oil Set for East. Office of Price Administration. Administrator Henderson today said: "As of January 7, we are reducing by one quarter the amount of all fuel oil rations allowed for heating non-dwelling space in the 17 eastern states.

6th—War Emergency Pipeline in Use. Petroleum Administration for War. Crude oil is moving into the 24-inch War Emergency Pipeline at Longview, Tex., Administrator Ickes announced.

6th—Anthracite Prices Up 50 Cents a Ton. Office of Price Administration. Administrator Henderson today announced an increase in maximum prices of Pennsylvania anthracite of approximately 50 cents a ton, in Amendment 10 to MPR 112, effective January 9.

5th—Petroleum Deliveries East at High. Petroleum Administration for War. Pipeline deliveries into seaboard States now running at all-time high, 160,000 barrels a day, according to Administrator Ickes.

5th—H. M. Besheres Heads Heat Exchange. War Production Board. Hugh M. Besheres, formerly Chief of Project Service Branch of the Construction Bureau, New York City, has been appointed Chief of Heat Exchange Branch of the General Industrial Equipment Division, it is announced today.

4th—Builders Advised to Consult in Advance. War Production Board. Saving in time and money by applicant for construction projects can be effected by suing the preliminary service of the Materials Control Branch of the Construction Bureau of WPB, it is suggested. In this way builders can be advised of latest regulations.

4th—Plumbing Restrictions Release Corrected. War Production Board. The ninth paragraph of Press Release T-1496 announcing further restrictions on metal in plumbing fixtures, is corrected to read: "Plumbing fixtures to be used in chemical plants, laboratories or hospitals and to be installed in any aircraft or vessel (other than a pleasure craft) *where the use* of other materials is impractical are excepted from all provisions of the order."

4th—Warn Oil Users to Redeem Credit Notes. Office of Price Administration. Householders who have refused to redeem "coupon credit notes" issued to dealers for purchases of fuel oil in the 30 state rationed area are warned by OPA they face suspension of ration.

3rd—Conversions Must Be Made This Month. Office of Price Administration. All commercial buildings which can convert to coal in the 30 States where fuel oil is being rationed are given the choice of converting or losing their rations by the end of this month in a message being sent to every local board by Administrator Henderson.

2nd—Period 3 Fuel Oil Coupons Cut 10%. Office of Price Administration. Administrator Henderson, upon advice of PAW as to the increasing gravity of the petroleum situation because of transportation problems and military requirements, announced that as of 12:01 A.M.? Monday, Jan. 4, Period 3 Fuel Oil Ration Coupons in the 17 Eastern States and D. C. will be reduced 10% in value.

1st—Fuel Stockpiles Required of Gas-Users. War Production Board. Natural or manufactured gas may be cut off from users who fail to provide themselves with fuel to operate their standby equipment, according to amendments just issued to Limitation Order L-31 (natural and mixed gas) and L-174 (manufactured gas).

Sizing Small Pipe Columns

THE question often arises as to what size of pipe should be used in figuring column supports for hot water storage tanks, air conditioning equipment, air receivers, and the like.

Tables giving the allowable loads for pipe columns are available, but these usually deal with the large sizes only, where the loads are relatively very heavy, such as for building supports, and the data consequently are not applicable for the uses mentioned.

For the purpose of providing this information the accompanying table has been drawn up. This lists available loads for pipe diameters from one inch up to six inches, inclusive, and for various lengths between two and 20 feet.

The allowable loads shown are for standard weight steel pipe, with wall thicknesses and transverse metal areas conforming to the specifications of the American Standard for Wrought Iron and Wrought Steel Pipe.

The following formula, recommended by the American Institute of Steel Construction, was used in computing allowable unit stresses in the column walls, and upon this the load values in the tables are based:

$$S = 17000 - 0.485 \frac{l^2}{r^2}$$

in which

S = unit stress in pounds per square inch
l = length of column in inches, and
r = radius of gyration.

The figures in the table are for slenderness ratios $\left(\text{ratios of } \frac{l}{r}\right)$ which are not greater than 120. This is the commonly accepted safe limit for main compression members, which is the classification in which supporting legs for tanks and similar equipment would fall.

The radius of gyration was computed from the mean of the inner and outer pipe radii, using the formula

$$r = 0.7071 \frac{p_1 + p_2}{2}$$

where p_1 and p_2 are the internal and external radius of the pipe, respectively.

It should be carefully noted in using the table that allowable loads given are for concentric loading only wherein the action of the load coincides with the axis of the column. They are not applicable for eccentric loading, and proper allowance should be made when the type of loading is questionable. Such things as floor slope, uneven spots in the floor on which the column bases rest, side thrust resulting from expansion and contraction of the connecting pipe—these all contribute to eccentric loading and must be considered in arriving at the correct pipe size. On the other hand, tanks are seldom supported on unbraced legs only, but nearly always on cradle-like structures with cross-ties and braces which tie the columns together into a rigid unit, and this construction makes for concentric loading, tending to offset the eccentric forces mentioned. Scale-holes and other possible flaws in the pipe, the chances of the pipes corroding in service, of being subjected to unusual bumps and shocks, and other such factors all help govern the choice of size. As a result, selection is bound to be a matter of common sense and sound judgment, quite as much as of exact figuring. The table does show, however, as do similar tables which list the larger load ranges such as are found in building construction, that columns properly installed and properly aligned can be enormously strong.

ALLOWABLE LOADS ON STANDARD PIPE COLUMNS

Nominal Pipe Diameter, Inches	Height of Column, Feet									
	2	3	4	5	6	8	10	12	15	20
	Allowable Load, Thousands of Pounds									
1	7.8	6.6	5.3	—	—	—	—	—	—	—
1¼	10.7	9.9	8.8	7.3	—	—	—	—	—	—
1½	13.1	12.3	11.2	10.0	8.3	—	—	—	—	—
2	17.8	17.2	16.4	15.3	13.9	—	—	—	—	—
2½	28.4	27.8	26.9	25.7	24.2	20.6	—	—	—	—
3	37.4	37.0	36.2	35.0	33.8	30.5	26.5	—	—	—
3½	45.1	44.6	44.0	43.1	41.9	39.0	35.2	30.4	—	—
4	53.6	53.0	52.4	51.5	50.4	47.8	44.1	39.8	32.2	—
4½	62.3	62.0	61.3	60.4	59.5	56.9	53.5	49.6	42.3	—
5	72.8	72.3	71.6	71.0	69.8	67.6	64.5	60.7	53.9	—
6	94.5	94.1	93.6	93.0	92.0	90.0	87.1	83.7	77.5	63.8

NO. 2 OF A SERIES

HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY

The FIRST WELDING FITTINGS 1ST AND STILL THE BEST

Two ways that Tube-Turn welding fittings avoid wasting men and hours in war plants!

Faster installed, trouble-free piping steps-up production schedules!

TUBE-TURN fittings speed up piping installation four ways: (1) Need only butt-welds, easy for veteran or novice welders. (2) Less lining-up, for fittings have *uniform* walls and true circularity. (3) Sections pre-assembled on the ground save time. (4) Torch cutting and fabricating are eliminated. Tube-Turn fittings are ready to weld—types, sizes and weights for all needs.

You can depend on piping welded with Tube-Turn fittings to be practically maintenance-free, as Tube-Turn welding fittings give the *greatest possible strength* and *long life*. They're *permanently leakproof*. There are no bolts to loosen, no gaskets to replace, no threads to corrode and weaken.

No plant *ever* can afford a break-down or production slow-up, but in war-time it's a disaster! The best insurance in the world against trouble in piping systems is *welding* with *Tube-Turn fittings!*

TUBE TURNS, (INC.) LOUISVILLE, KY. ● *Branch Offices*: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Tulsa, Houston, Los Angeles. ● *Distributors in principal cities.*

TUBE-TURN TRADE MARK *Welding Fittings*

OTHER WAR-TIME ADVANTAGES:

SAVES CRITICAL MATERIAL: Absence of many flanges, bolts, nuts and heavy cast steel construction saves many tons of metal in a single piping system.

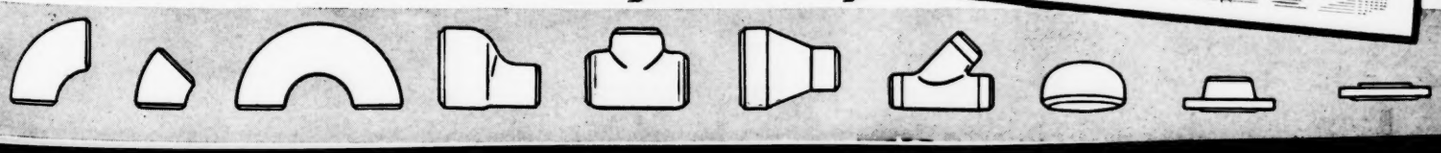
FASTER AND EASIER TO INSULATE: Tube-Turn fittings are insulated as easily as the pipe itself, for the welds form one continuous tube.

SAVE SPACE: Pipe systems welded with Tube-Turn fittings permit streamlined, compact layouts and sharp angles.

LAST LONGER: Smooth inner walls—with no ridges, waves or scale—means less corrosion and longer life.

LESS PRESSURE LOSS: Because of full effective radius and exact O.D. and I.D. alignment with the pipe, the flow is more efficient and pressure loss is less.

FEWER SUPPORTS NEEDED: Since welded piping weighs less and stands vibration better than flanged systems, few hangers or supports are required.



NEWS OF THE MONTH

WPB Order Limits Inventories

Certain manufacturers of heating, ventilating and air conditioning equipment, and many jobbers and dealers engaged in handling the equipment, may be affected by a new WPB order, along with the thousands of retailers, jobbers, wholesalers, or any others throughout the country engaged in the marketing of consumers' goods, either of their own or another's manufacture, who maintain mercantile inventories.

The new order, known officially as WPB Limitation Order L-219, specifically limits the quantities of consumers' goods that retail merchants, wholesalers, and stock carrying branches of manufacturers may have on hand. The purpose of the order is to insure equitable distribution of the diminishing amounts of consumers' goods that will be available to the public as the war develops.

Under the terms of the order, consumers' goods are defined as goods suitable in form and type for sale to individual ultimate consumers for personal or household use. The order will apply to every merchant who, on or after November 30, 1942, had a mercantile inventory of consumers' goods having a cost value of $50,000 or more at the end of any quarter of any of his federal income tax years; and also, during the twelve months preceding the end of the same quarter of his federal income tax year had net sales of consumers' goods of $200,000 or more.

Merchants with inventories or net sales below these limits are exempted and need file no report. Exemption is provided also when 50% or more of a merchant's total business is made up of certain items specifically mentioned in a list appended to the order. This list includes coal, fuel oil, gasoline, and miscellaneous heat or power fuel, as well as lumber and most building materials.

A mercantile inventory is defined as a stock of consumers' goods held for sale by a person engaged in marketing such goods, including goods he has purchased for resale, goods he has manufactured for sale, stock consigned to him for sale, and stocks held by him on memorandum for sale.

The new order is expected to bring about and maintain a ratio of consumers' goods inventories to sales at approximately a pre-Pearl Harbor status, thus assuring the availability of larger quantities of goods for smaller merchants.

I-B-R Research Continues

CHICAGO—Manufacturers of boilers and radiators have renewed their contract with the University of Illinois for the continuation of the research program in hot water and steam heating underway at that institution. The renewal of the contract assures the continuation of The I-B-R Research Program at least until June 30, 1944. The program is dedicated to the economic and technical improvement of hot water and steam heating.

The continuation of the I-B-R Research Program during the war period will assure the steam and hot water heating industries of a favorable post-war market position in that they will have available a large fund of data resulting from the uninterrupted study of steam and hot water heating plants.

The I-B-R Research Program is sponsored by the following members of The Institute of Boiler and Radiator Manufacturers:

Burnham Boiler Corporation, Columbia Radiator Company, Crane Co., The Eastern Foundry Company, International Heater Company, Kohler Co., The National Radiator Co., The H. B. Smith Company, Inc., Spencer Heater Division, Thatcher Furnace Company, United States Radiator Corporation, Utica Radiator Corporation, Weil-McLain Company.

Army Men Taught Heating

PHILADELPHIA—The United States Army is sponsoring special training for a group of its combustion engineers to make sure that the barracks and hotels in which troops are housed are heated with the greatest possible economy of fuel.

The selected staff of officers recently completed an intensive course of training here at the school operated by the Brown Instrument division of Minneapolis-Honeywell Regulator Company, which manufactured much of the instrument equipment already installed in camps and where the Army has taken over large housing facilities, a company official said.

The Brown school, which has been training men from many ordnance and war plants in the use of industrial instruments, arranged a special course for the officers. The men learned the use and maintenance of such instruments as flow meters, CO_2 meters, and other devices.

The officers, who are assigned by the office of the chief of Army Engineers, included: Capt. J. B. Bullock and Carl Miller, office, chief of engineers, Washington; Lieut. David W. Jones and Richard D. Wooley, second command area, New York; Capt. Roy L. Merritt and Ashley H. Thomas, fourth area, Atlanta; and others.

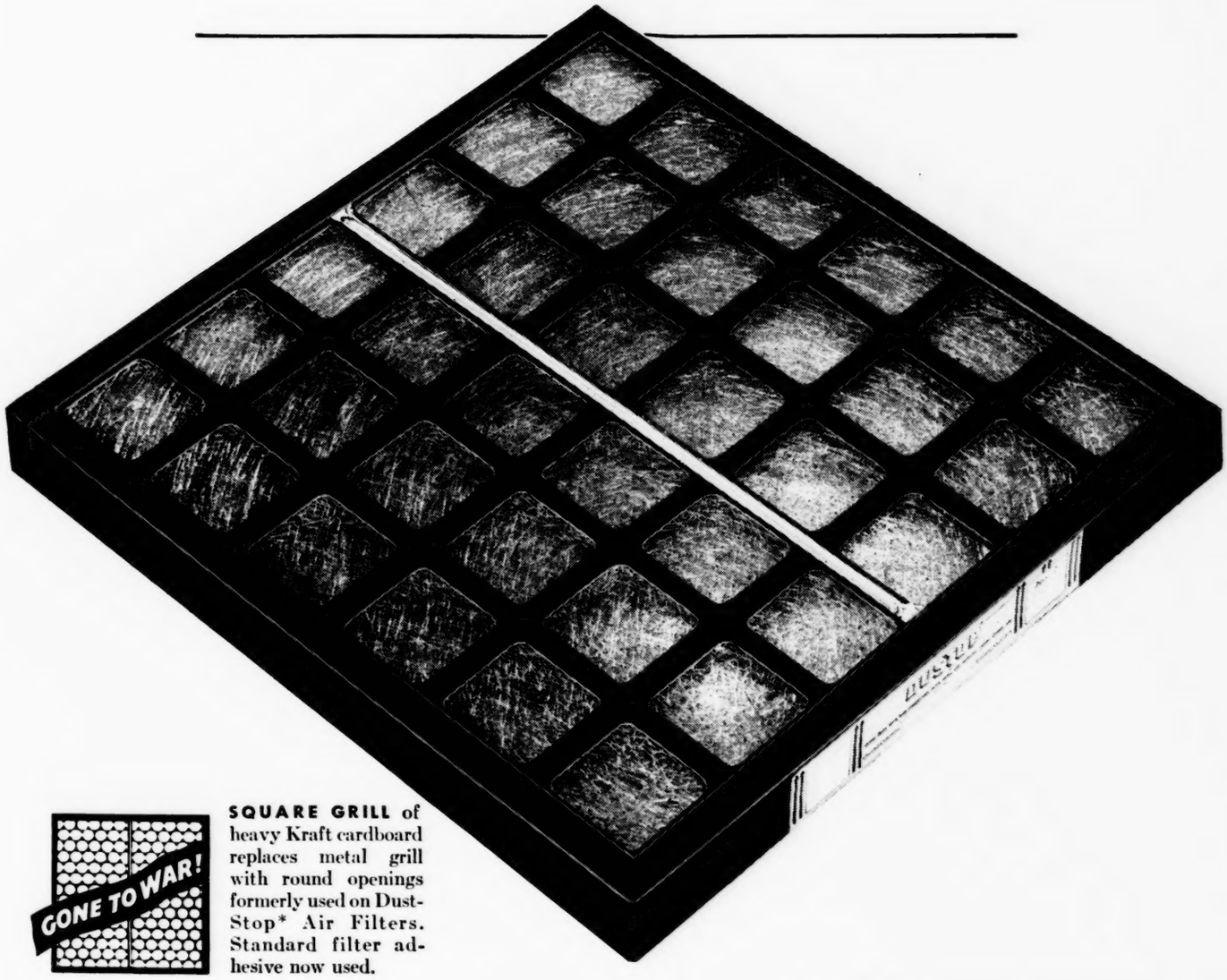
Blankin Elected by ASHVE

CINCINNATI—At its 49th annual meeting here January 25-26, the American Society of Heating and Ventilating Engineers installed 1943 officers as follows: president, M. F. Blankin, Philadelphia; first vice-president, S. H. Downs, Kalamazoo, Mich.; second vice-president, Prof. C.-E. A. Winslow, New Haven; treasurer, E. K. Campbell, Kansas City, Mo. For members of the council, elected for three-year terms will be: John F. Collins, Jr., Pittsburgh; Prof. James Holt, Cambridge, Mass.; E. N. McDonnell, Chicago, and Lt.-Comdr. T. H. Urdahl, Washington.

The membership elected five members of the committee on research for three-year terms, as follows: H. J. Rose, Pittsburgh; L. P. Saunders, Lockport, N. Y.; Prof. L. E. Seeley, New Haven; Comdr. A. E. Stacey, Jr., Washington, and C. Tasker, Toronto.

The new ASHVE officers: (Left) M. F. Blankin, president; (Center) S. H. Downs, first vice-president; (Right) Prof. C.-E. A. Winslow, second vice-president.

HERE IS DUST-STOP'S NEW "WAR" FILTER!



SQUARE GRILL of heavy Kraft cardboard replaces metal grill with round openings formerly used on Dust-Stop* Air Filters. Standard filter adhesive now used.

1 Quickly available
2 Price and maintenance economy the same
3 Filtering efficiency maintained
4 Saves critical metals and materials

BOMBER and tank plants, instrument manufacturers, scores of other war industries are using Dust-Stops in such great quantities that more of these filters were sold in 1942 than in any other year.

For dust control in precision manufacture means mechanical ventilation or air conditioning. And the makers of such equipment recognize the importance of Dust-Stops and include them in their systems.

Householders, too, have been using Dust-Stops in greater numbers than formerly. For clean filters help assure top efficiency from forced warm air furnaces—a big point with fuel rationing.

It was the responsibility of Dust-Stop engineers to meet this increased demand. They met it by designing a filter—the new "war" filter—which saves critical materials and keeps most of the advantages of the former Dust-Stop.

Most Advantages of the Leader in the Filter Field Remain Unchanged

Performance: Capacity, 2 CFM per sq. in. of area at 300 FPM. Average resistance, new, in inches of water gauge, .065 for 1-inch, .13 for 2-inch.

Economy: Cost only 1c per CFM as original equipment for industrial installations. Less than 1/10 of 1c per CFM to replace.

Maintenance: Filter face can be vacuum cleaned or rapped out, this practice can be repeated once or twice, further reducing maintenance costs.

Easy to Change: Anyone can replace dirty filters with new Dust-Stops in a jiffy.

Availability: Made from all-American materials which are not now listed as critical. Production is being expanded to meet growing requirements.

What about Fire-safety? The famous non-inflammable Dust-Stop adhesive is no longer available. As a substitute, standard filter adhesive are now used. The filter media is still made of incombustible glass fibers.

Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.

FIBERGLAS* DUSTOP* AIR FILTERS

*T.M. Reg. U.S. Pat. Off.

Dust a Factor in Night Club Fire

BOSTON — Some curious facts have been brought out in the investigations of the Cocoanut Grove fire which resulted in a total of some five hundred deaths. The practice of making fire inspections without regard for atmospheric conditions at the time of inspection, was criticized by a professor of meteorology at one of the local universities. In his criticism it was pointed out that the last fire department inspection of Cocoanut Grove was made on November 20, the dampest day of the month. When the tragedy took place, moisture in the air was only one-fifth as great as on the day of inspection. It was contended that if the inspection had been made on another day, the materials that would not burn on November 20 might have been found inflammable.

In conducting an investigation independent of the Boston Fire Department inquest, coordinating State agencies have been in touch with a Cincinnati authority on dust explosions, who reached the conclusion that the disaster was due in a large degree to a dust explosion. In his report to the state agencies, he points out:

"All foliage decorations gather amazing quantities of dust in a few months. If you will visit the fly gallery of a theatre you will see what I mean. The bus boy dropped a match, as he told you. He started a tiny blaze on a palm leaf. Trying to put it out with his hands, he shook the leaves of the palm tree, laden with the dust of months.

"Instantly a cloud of dust spread for 10 or 12 ft. The tiny blaze ignited this and it exploded into flame like so much gasoline. The shock of this flash shook all the palm leaves in the room . . . the whole place for a fraction of a second was filled with fine dust and then it all blew up.

"Flame from this was enough to set fire to the palm trees, fire-proofed as they probably were. Theatrical fire-proofing is only to make the material char for a while before it goes into flame, and gets out of control. The carbon monoxide generated by the original explosion killed people like flies. The more the palm leaves smouldered before bursting into flame, the more gas was generated."

There was practically no air conditioning at Cocoanut Grove, and the ventilation was of a very sketchy sort. According to reports, there were only two small floor air conditioning units and some small fans.

A.C. for Blackouts Discussed

LOS ANGELES—Heating, ventilating and air conditioning problems encountered in wartime construction were discussed in a talk before Southern California chapter of the ASHVE January 13 by Lieut. Col. Harry W. Thompson, chief of the military engineering division, Los Angeles district.

Col. Thompson, who is in charge of military engineering for the district, discussed the subject from the standpoint of design of heating and air conditioning of airports, army cantonments and appurtenant facilities.

"Air Conditioning Design for Black-out Plants" was the subject discussed by three speakers. H. M. Hendrickson, York Ice Machinery Corp., handled the subject with respect to load design and methods of installation; W. O. Stewart, Johnson Service Co., discussed it from the standpoint of controls for air conditioning systems, while Maron Kennedy, York Ice Machinery Corp., treated central air conditioning systems versus multiple type systems.

Survey Shows Heating Trends

BIRMINGHAM, ALA.—Only 22% of Birmingham homes have central heating plants and the rest depend on grates and other forms of individual room heaters, according to a survey of 61,883 local dwellings by T. W. Langford, chief smoke abatement inspector of the city.

Of the 13,614 central home heating plants 6,000 have stokers, 5,000 use gas, and the balance are hand-fired, mostly with coke according to the survey. During the past year 447 domestic and 41 industrial stokers were installed, as compared with 960 domestic and 230 industrial in 1941.

Due to the war and the dearth of stokers and parts as well as to the shortage of coke, the city has had to let up on the enforcement of its smoke abatement ordnance and resort more to educational work.

MOHA Elects Eldridge

BOSTON—Officers of the Massachusetts Oil Heating Association for 1943 were elected at the twentieth monthly meeting Jan. 12, as follows: president, Ray E. Eldridge, Framingham; vice-president, Orodon S. Hobbs, Malden; secretary-treasurer, Fred N. Beckwith, Boston; directors, Clarence L. Vanderwarker, Taunton; Herbert S. Carragher, Lowell; Earle S. Chapin, Reading; Clarence A. Warner, Medford; Wat Tyler, Cambridge; Alfred W. Barr, Watertown; Walter C. Crooker, Boston.

Frank Elected by NAFM

BUFFALO—J. M. Frank was elected president, J. M. Birkenstock vice-president, and L. O. Monroe secretary-treasurer of the National Association of Fan Manufacturers.

David C. Johnson

NEW YORK—David C. Johnson, president of the New York Steam Corporation and vice-president of the Consolidated Edison Company, died Dec. 19 of a heart attack. His age was 57.

Entering the board of directors of the New York Steam Corporation in 1922, he was elected a vice-president in 1927 and president the next year. In May, 1937, soon after the merger of the company with Consolidated Edison Company, he was elected a vice-president of the latter corporation. In March, 1937, he was made a trustee as well.

He leaves a widow, a son, a sister, and a brother.

W. W. Lewis

MIDDLETOWN, O.—W. W. Lewis, 55, Assistant Vice President of The American Rolling Mill Company died here suddenly on January 23, while playing golf with three of his Armco associates. Death was due to coronary thrombosis.

A genial and capable executive, Mr. Lewis progressed rapidly through positions which included head of what is now the Market Development division, Superintendent of the Ashland Kentucky Open Hearth Department, General Manager of the London Branch of Armco International Corporation, and the position he held at the time of his death.

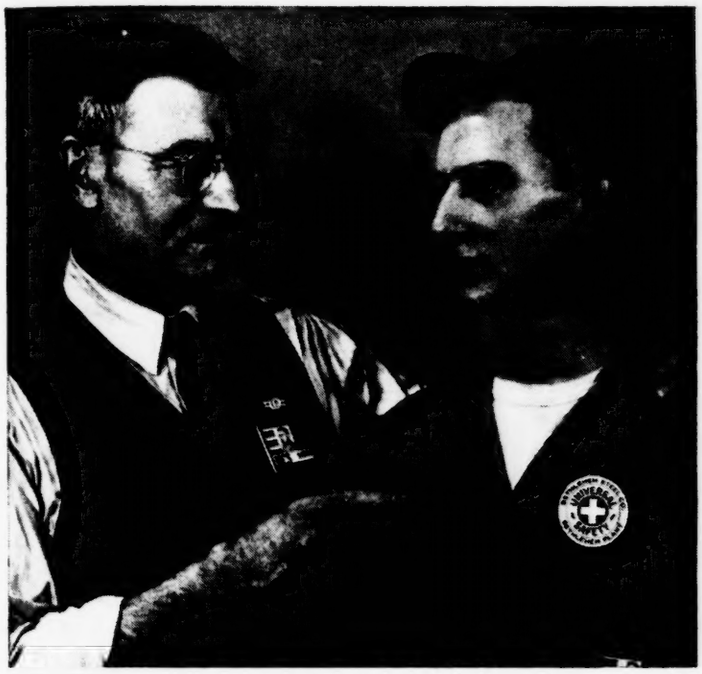
He is survived by his wife, two sons, and a daughter.

Post-War Fuel Oil Ban Hinted

NEW YORK—American industry may be obliged to stop burning oil for heat and power not only for the duration of the war but as a permanent policy, Mark Anton, acting chief of the fuel oil division of the Petroleum Administration for War in the Eastern area, stated here recently.

Mr. Anton, explaining the latest Petroleum Administration order to the Purchasing Agents Association said that the thinking in government offices is directed toward eventually confining oil to the uses for which it is best suited—automobile and airplane engines—and using coal for other purposes. Known coal reserves are 500 times as great as oil reserves, he pointed out.

SAFE WAYS IN WAR PRODUCTION

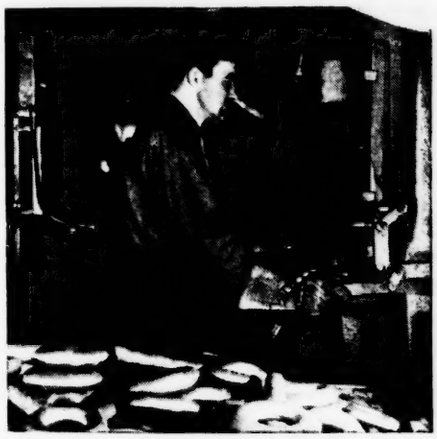


NEW WORKER—Every new employee in a Bethlehem Plant wears this button. It helps to fix his attention on safety. It signals to more experienced employees that he is new to the plant, and they keep an eye on him, and do not hesitate to offer friendly guidance in case he forgets instructions and unknowingly breaks any safety regulation.

Industrial accidents, bad enough because of the human distress they cause, are also a grievous drag on production. Every day that injury lays up a worker means lowered output of the materials our armed forces are asking for.

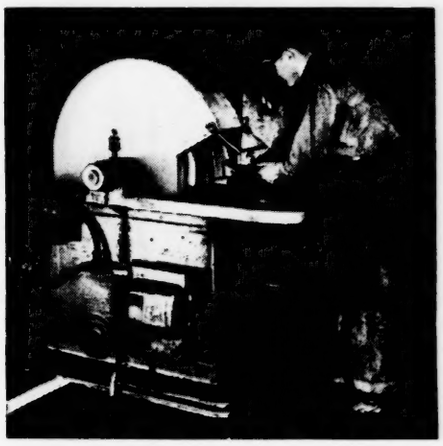
Safety engineers know they must be more than ever on guard as pressure for production intensifies and men work against time. When war came, Bethlehem Steel Company expanded its accident-prevention program to meet the new conditions. Special efforts were addressed to the new employee to make him safety-conscious from the moment he walked into the plant. And by posters, group meetings and individual instruction, the safe way of doing his job was ground into the subconscious of new Bethlehem employee and veteran alike.

Significant are the results of a current study, showing that of all disabling accidents to Bethlehem employees less than one-third occur in the course of their work. Even with employment rolls upped by the tens of thousands and plant operations at top speed to meet the demands of the war program, the Bethlehem employee is safest, best protected against injury, during the hours he spends on the job.



AUTOMATIC HAND GUARD—This man is operating a trimming press. If he should absent-mindedly let his hands move too near the danger zone, the two cables will automatically whisk them back to safety, before the ram of the press descends.

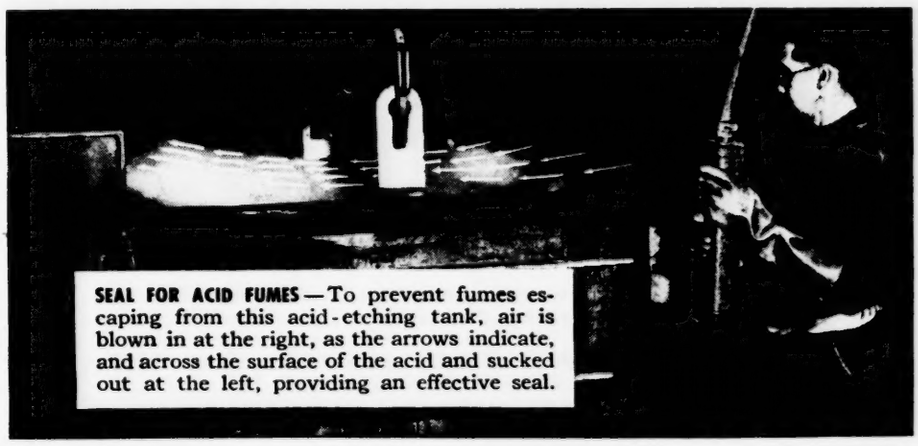
100% HEAT-INSULATED—Asbestos-covered hood, chrome-leather full-length apron, chrome-leather gloves, chrome-leather full-length sleeves and asbestos guard on torch handle give this worker complete protection against heat and flying sparks.



EYES DOUBLY GUARDED—Even though this grinder is equipped with a heavy glass shield, the eyes of the man who is operating it are given further protection against sparks or flying bits of abrasive by the cup goggles that he is wearing.

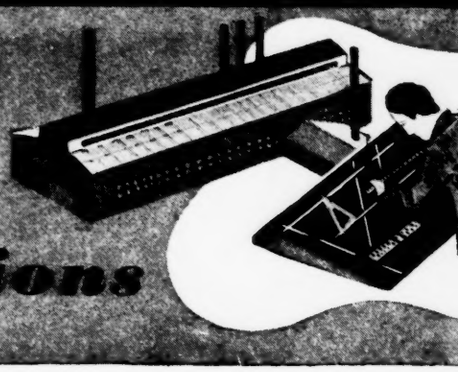
BETHLEHEM STEEL

Bethlehem Steel Company is actively supporting the National Safety Council in its campaign against accidents in war production, through the War Production Fund to Conserve Manpower.



SEAL FOR ACID FUMES—To prevent fumes escaping from this acid-etching tank, air is blown in at the right, as the arrows indicate, and across the surface of the acid and sucked out at the left, providing an effective seal.

REVIEWS of TECHNICAL publications



WATER VAPOR TRANSMISSION

"Accumulation of Moisture in Walls of Frame Construction During Winter Exposure," Report BMS 93, by Charles G. Weber and Robert C. Reichel, National Bureau of Standards, Washington, D. C.

Tests made in Washington, D. C. on the condensation and accumulation of moisture in seven different kinds of frame wall construction are described in this report. The arrangement of materials and instruments used in the tests is shown in Fig. 1.

The humidity and temperature of the inside air were controlled to produce an average vapor-pressure drop across the wall of approximately 0.2 lb. per square inch. Temperatures were measured with the use of thermocouples (t_1, t_2, etc. in Fig. 1) and a suitable potentiometer. Moisture data were obtained by checking the weights of specimens of photographic blotting paper (M_1, M_2, etc.) of known relative-humidity-moisture-content relationship.

Results showed that (1) use of a good vapor barrier on the warm side of the wall prevented condensation; (2) in every instance where no vapor barrier was used on the warm side of the wall, condensation occurred within the wall; (3) the use of a vapor barrier on the cold side of the wall increased the accumulation of moisture; and (4) the performance of walls of standard wood construction was not basically different from those containing fiber sheathing boards.

Paper covered, 5 pages, size 8 x 10½ in.

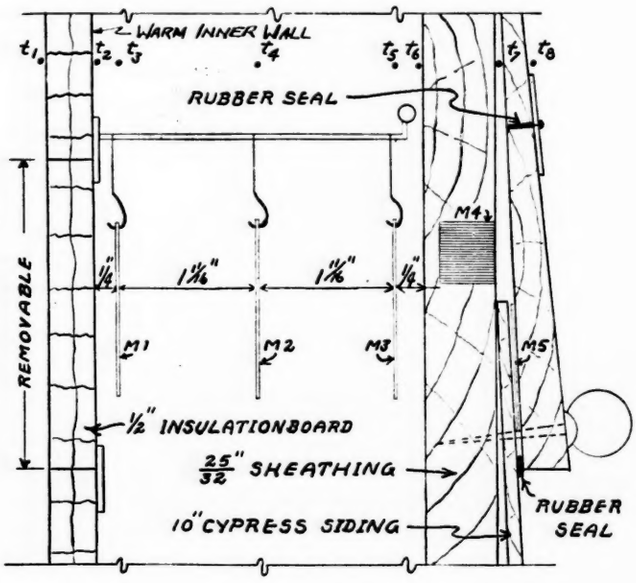


Fig. 1.

FUEL CONSERVATION

"Save Fuel for Victory," Circular No. 47. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

A series of non-technical talks delivered in recent months over the University's radio station WILL and having to do with insulation, heating plant efficiency, and similar subjects, has been compiled in this 35 page, 6 x 9 in., paper-covered booklet.

A limited number of the booklets are available free from the Engineering Experiment Station any time up to July 1, 1943 or until supply is exhausted.

HOUSING CONSTRUCTION

"Building Materials and Structures Report BMS 88." For sale by the Superintendent of Documents, Washington, D. C. Price, 20 cents.

This report of the U. S. Dept. of Commerce Subcommittee on Building Codes, Central Housing Committee on Research, Design, and Construction, lists the recommended building code requirements for new dwelling construction, with special reference to war housing. These requirements apply to single and two-family houses and to multiple dwellings of limited height. Fire resistance, light and ventilation, exits, strength of construction, and chimneys and fireplaces are among the subjects covered. Additional information is given in an appendix which includes methods of getting specific code provisions and references to source material.

Bulletin is paper covered, 8 by 10½ in., 88 pages.

CRITICAL MATERIALS CONSERVATION

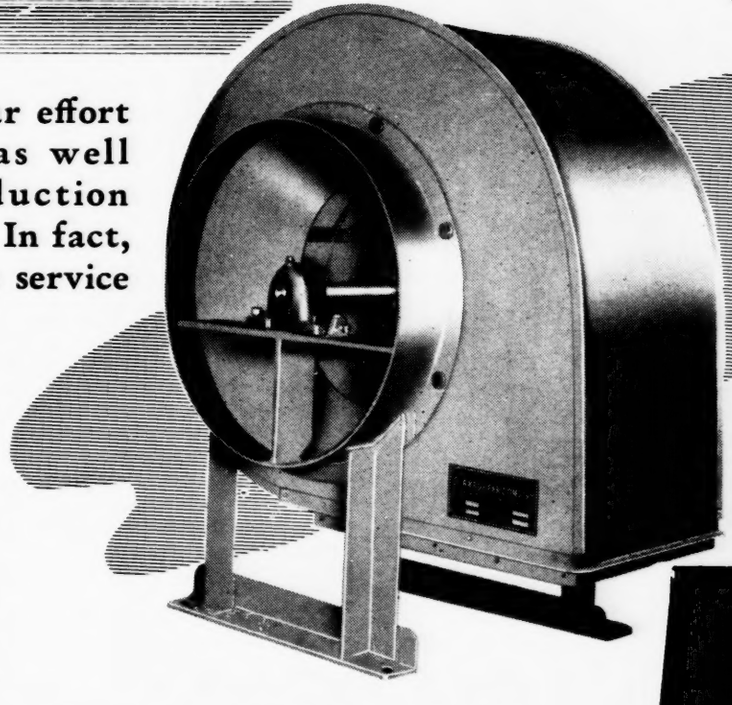
"Wartime Design Restrictions for Conservation" by T. W. Reynolds. Published by The Industrial Press, 148 Lafayette Street, New York, N. Y., from HEATING AND VENTILATING, February, 1943. Price, 25 cents.

The selection and use of suitable substitutes to replace critical materials normally used in heating, ventilating and air conditioning work calls for increasing ingenuity and a specialized knowledge of conditions as the war progresses. This 12-page standard size pamphlet, printed in russet colored ink on India tint coated stock, lists in detail a good many such replacement items together with their properties, and suggestions for making use of them. The pamphlet constitutes HEATING AND VENTILATING'S Reference Section No. 9.

FANS for Ship Ventilation

and Every Other Air-Handling Service

Clarage serves the war effort on the seven seas, as well as in the vital production plants of this Nation. In fact, Clarage Fans were in service on many a warship and freighter that helped produce Victory in World War One. *And today we're repeating the performance*—with greatly increased manufacturing and engineering facilities.



NEW TYPE FAN designed especially for ship ventilation; all steel construction; nothing to break or shatter; light weight.

Time-Tested Equipment for War-Time Needs . .

No matter what you need in the way of ship ventilation, mechanical draft equipment, or fans for any other air-handling duty, Clarage is prepared to meet your requirements IN TIME. By using Clarage Fans, you get the recognized utmost in compact design and efficient, dependable operation. Write or wire!

Clarage Fan Company Kalamazoo, Mich.

APPLICATION ENGINEERING OFFICES IN ALL PRINCIPAL CITIES

FOOD DEHYDRATION

EDITOR, HEATING AND VENTILATING:

I have not yet had an opportunity to analyze and digest the section on Food Dehydration which appears in the December, 1942, issue of HEATING AND VENTILATING, but, in glancing through it, have noted some statements I wish to comment on and some omissions to which I take the liberty of bringing to your attention. These remarks apply almost entirely to the dehydration of vegetables. Processing meats is another matter.

Material:—It is most important that none but sound suitable material be used. The process adds nothing to the material and the product can be no better than the original substance. All varieties of vegetables are not equally suitable for dehydration, according to most authorities. The vegetables must also be at the proper stage of growth, for best results; i.e., as sometimes said "at the stage at which they would be suitable for the table."

Preparation:—Proper preparation of the material, prior to dehydration, is most important — fully as important as any of the subsequent processes.

Blanching:—If this operation is not properly carried out, there is not much use in proceeding with dehydration, as the product will deteriorate rapidly. The blanching should be followed by dehydration with as little delay as possible. Mr. H. C. Arthur's investigations indicated plainly that the inactivation of the enzymes is not a permanent condition, but more in the nature of a paralyzing shock from which they begin to recover in a comparatively short time.

Sulfuring:—This process is advocated by many for certain materials and, when used, takes the place of blanching. It is applicable to fruits, particularly. I did not notice any mention of it.

Curing:—I did not find any particular mention of this, in the article, as a desirable post-dehydration operation. Many authorities advocate it, strongly, for the purpose of final moisture control and uniform distribution throughout the product.

Vitamins:—The matter of the vitamin content of dehydrated foods must be given careful consideration and general statements regarding it should be made with great caution. Vitamin C, for example, under certain conditions, is of a very fugitive nature. It is readily lost by oxidation and, hence, departs quickly from thin slices of fresh vegetables. Dr. Frederick Tisdall points out that it is entirely lost during the action of grating raw potatoes and raw apples; and the same will be true in other cases. It is said that in the act of chewing, as much as 50% of the vitamin C content of the substance chewed may be lost. Furthermore, the juice of fresh oranges, or other citrus fruits, left standing in an open vessel for 24 hours, even though in a refrigerator, will lose practically all of the vitamin C content which has not been previously destroyed in the act of squeezing or reaming.

Vitamin B content is said to be materially decreased by overheating and according to Dr. Bate-Smith, about 30% to 50% of the vitamin B, is lost during the preliminary cooking (of meats), but no loss of either nicotinic acid or riboflavin was found where the temperature was kept below 158° F.

Critical Points:—The entire process consists of a series of interrelated steps, upon each of which the subsequent operations depend for their success. The nature of the material must determine many of the conditions imposed, such as air velocities, temperatures, humidity control, etc.

Tomatoes are said to require extreme care in packaging and must be sealed in containers immediately after dehydration, without curing, as they are rated as highly hygroscopic.

Palatability:—There is considerable disagreement in regard to this matter. Actually, the same material may not result in similar tasting products unless the processing is identical. I take exception to the general statement that high seasoning and cream sauces are necessary to smother the taste. My own experience, extending back as far as 1915, does not lead me to that conclusion. However, tastes differ, but nevertheless, much depends upon the particular method of dehydration used, the nature and condition of the fresh material and the care with which the processing is carried out.

Vacuum Dryers:—Products dried in a vacuum should be packed in a vacuum or in an inert gas, if removal of oxygen is to be claimed as a benefit. Furthermore, the container must be of a type and material which will withstand the external pressure, for packing in vacuo, and hence relatively expensive.

Tunnel Dryers:—The tunnel dryer, if regarded as an enclosed space, may be considered as "essentially a form of compartment dryer", but the operation of it may differ considerably from the compartment dryer, owing to the different methods which can be used for introducing and exhausting or venting the air and the travel (or progression) of the material with reference to it and the method of taking advantage of the humidity pick-up, especially in the "hot end charging", or concurrent type and its variations.

Drum Dryers:—While these are used as your article mentions, they are also used in the first stage (or precooking) of meat, prior to dehydration. The dryer in the cut is of the single drum-roller type. For certain purposes, the double drum dryer is preferred by some.

J. J. Woolfenden
Smith, Hinchman & Grylls, Inc.,
Detroit, Mich.

. . . full speed ahead . . .

for the Food Fleet . . . cargoes of square meals . . . the kind of grub the boys deserve. And no matter how long the voyage their food will be delivered as fresh as the day the convoy sailed.

Air Conditioning . . . Refrigeration . . . Go to Sea

TURNING OUT refrigeration and air conditioning equipment for hundreds of fighting ships and merchant vessels is a vital war task shouldered by the men and women of Carrier.

To the crews of these ships, "Carrier" means food as wholesome as in your own home. To fighting forces overseas, "Carrier" means tons of perishable supplies delivered fresh wherever needed. To men in compartments that are sealed during battle, "Carrier" means the very air they breathe.

Years ago Carrier designed equipment to withstand the pounding of seas and the corroding effect of salt air and water. Today Carrier equipment for mechanical cooling and air conditioning is used extensively for vessels of the United States Navy, United States Maritime Commission and other government agencies as well as by steamship lines throughout the world.

And on land, too, Carrier equipment and engineering provide dependable control of temperature, humidity, cleanliness and circulation of air for war production. Carrier technique has been solving industrial air conditioning problems since before World War I.

Carrier engineers will gladly discuss the application of Carrier Air Conditioning and Refrigeration to meet your requirements. Call your Carrier representative or write to Carrier Corporation, Syracuse, N. Y.

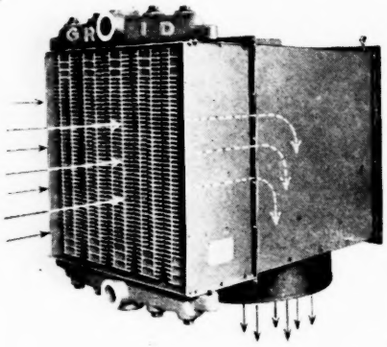
This most coveted honor, the Army-Navy "E", was awarded to Carrier Corporation for continued excellence in war production.

Carrier

AIR CONDITIONING

REFRIGERATION

NEW EQUIPMENT

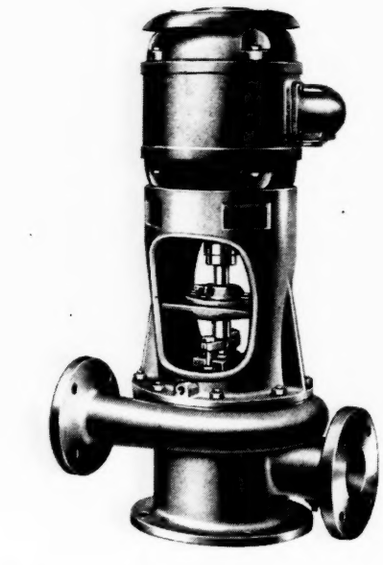


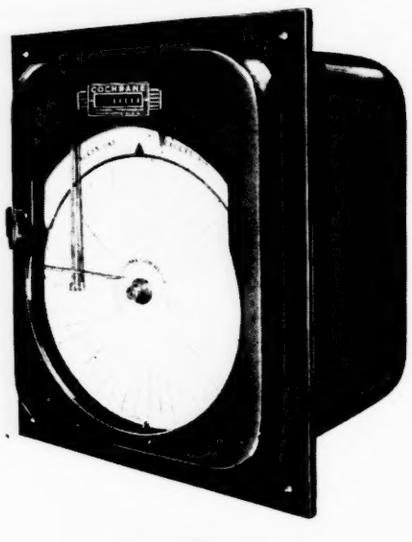
Cast-Iron Projection Heater

NAME — "Grid" Down-Blast Unit Heater.
PURPOSE — For projection type of heating, and to save critical materials.
FEATURES—The new cast-iron grid heating elements, replacing critical aluminum, are now available in a new down-blast type of unit heater, supplementing the horizontal discharge type recently announced. As in the earlier model, corrosion due to electrolysis is claimed to be completely eliminated since only one type of metal comes into contact with steam or hot water. The fan motor is so located as to be protected from the radiant heat of the unit itself, minimizing possibility of burning out motor.
MADE BY — *D. J. Murray Mfg. Co., Wausau, Wisconsin.*

Liquid Pump

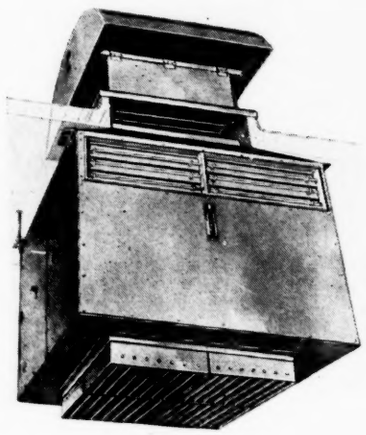
NAME—Economy Type S C V pump.
PURPOSE—For circulating hot or cold water or brine, for air conditioning and boiler feed applications, or for other uses where clear liquids are handled.
FEATURES—A side suction and side discharge unit with direct-connected motor and impeller mounted in a vertical frame, permitting easy removal of the entire pumping unit from the impeller housing by taking out a few bolts. Impeller is mounted on drive shaft between outboard and inboard bearings. Standard unit has bronze impeller, rings, and stuffing gland and corrosion-resisting shaft with cast-iron base and motor stand.
SIZES AND CAPACITIES—Six suction line sizes from 1½ to 4 inches, 10 to 500 gpm, 10 to 225 ft head.
MADE BY—*Economy Pumps, Inc., Hamilton, O.*





Flow Recorder

NAME—Cochrane 2-pen electric flow meter.
PURPOSE—For recording two related flow records on one chart, especially where panel space is limited.
FEATURES—Consists of two complete flow meter receivers mounted within one double depth case. Both receivers can be swung out and can operate in the out position. When measured quantities are nearly equal and pens track close to one another, a special red indicating pointer can be incorporated to indicate which of the two pens has the higher reading. The pointer movement is two and one-half times greater than the difference between the two pens and is thus much more readily noted. An integrating feature can be furnished.
MADE BY—*Cochrane Corporation, 17th and Allegheny Ave., Philadelphia, Pa.*



Unit Ventilator

NAME — Vertivent Heater and Ventilator.
PURPOSE — For heating and ventilating industrial plants under blackout conditions.
FEATURES — Unit consists of a ventilator-type air intake section mounted on the roof and an air tempering section with coils, fan and power unit enclosed in a housing suspended in the building. Hood on the roof prevents light leaks and keeps out the weather. The fresh air and recirculating dampers are interconnected and may be automatically controlled to maintain desired outlet temperature. Fan is of propeller type, driven by a totally enclosed motor with adjustable base through V-belts. Housing can be either of steel or non-metallic construction, painted with prime coat. Two types of diffuser outlets available.
SIZES AND CAPACITIES — Three models, 5000, 10,000 and 15,000 cfm respectively, with 1, 2 or 5 hp motors, and 30-, 36- or 42-inch fans.
MADE BY — *Young Radiator Company, Racine, Wisconsin.*

Rust Preventative

NAME—Rustbuster No. 3.
PURPOSE—For eliminating rust and corrosion in steam and water lines and boiler equipment.
FEATURES—Introduced into boiler water, this new chemical is claimed to counteract corrosion in the boiler and adjacent equipment, as well as in the piping and other parts of the entire system. Also has useful applications for the same purposes in air conditioning spray chambers, in condensate piping leading to cooling towers or evaporative condensers, and in chilled water lines.
MADE BY—*Cannon Chemical Company, Inc., Everett, Mass.*

FOR LOW-COST HEATING, QUICK INSTALLATION AND METAL CONSERVATION

DIRECTHERM
UNIT HEATERS
STOKER-FIRED

It is a self-contained unit and can be installed or moved in a few hours. No duct work, radiators, or pipes are necessary.

To tend a Directherm requires a minimum of attention. Once the automatic controls are set, they need not be changed. An unskilled man can take care of it . . . important in these days of labor shortage.

Made in 6 sizes (300,000-1,700,000 BTU).

AIRTHERM
MANUFACTURING COMPANY

722 S. SPRING AVE., ST. LOUIS, MO.

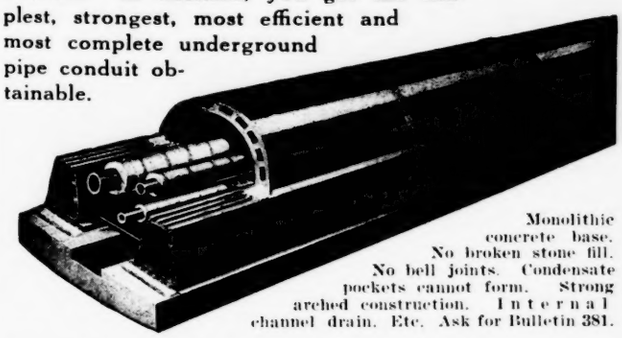
When you specify

THERM-O-TILE

Reg. U. S. Pat. Off.

Underground Pipe Conduit

You SAVE METAL when you specify Therm-O-Tile, and by saving metal you HELP WIN THE WAR. Pipe saddles and supports require the **only** metal in this conduit. In addition, you get the simplest, strongest, most efficient and most complete underground pipe conduit obtainable.



Monolithic concrete base. No broken stone fill. No bell joints. Condensate pockets cannot form. Strong arched construction. Internal channel drain. Etc. Ask for Bulletin 381.

Sold and installed by Johns-Manville Construction Units in all Principal Cities. See our page in Sweet's or The Heating Guide.

H. W. PORTER & CO., Inc.

823V Frelinghuysen Ave. Newark, New Jersey

Without obligating us in any way, ☐ Please send Bulletin 381. ☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective job, on which we shall be glad to have your ☐ comments, ☐ quotations.

Clip your name, firm, and address to this ad; tear out with the checked squares above, mail, and you will hear from us promptly.

This is no time to take chances! ...These famous stokers are available for wartime installations.

Let us help you!

FIRE-GUARD

Automatic Coal Stokers

Sizes from 66 to 400 lbs. capacity

Wire, Phone or Write NOW!

PEERLESS MFG. CORP. Louisville, Ky.

Heating Equipment for 58 years

Architect: Walter Martens, Charleston
General Contractors: H. B. Agston & Sons, Charleston

Modern Design .... Advanced Engineering and Carey

INSULATIONS

MAKE UNITED CARBON'S NEW HOME BEAUTIFUL, SUBSTANTIAL, EFFICIENT-

United Carbon's new office building at Charleston, W. Va., is a vision of modern design, beauty and color, with advanced engineering providing convenience and comfort facilities in keeping with the impressive architecture.

To insure the utmost efficiency in heating, air conditioning, and chilled water supply, CAREY Insulations were used extensively—Careycel Pipe Covering on low-pressure steam lines... CAREY 85% Magnesia on high pressure lines... CAREY Impervo on cold water pipe... also CAREY Insulation Cement, Magnesia Block and Air Cell Block in the heating and cooling systems. The air conditioning ducts were insulated with CAREY Rock Wool.

CAREY Insulations are the logical choice for modern construction where the utmost efficiency must be combined with permanence. Whatever your insulation requirements, you can make sure of maximum performance by using CAREY Products. A nationwide service organization is at your command. For details, address Dept. 49.

THE PHILIP CAREY MANUFACTURING COMPANY • Lockland Cincinnati Ohio

NEW CATALOGS

CONTROLS

General Electric Company, Schenectady, N. Y.

GEA-1724D is a new standard size 12-page catalog dealing with synchronous-motor control. Starting, accelerating, synchronizing, and other functions performed by both magnetic and semi-magnetic types of full and reduced voltage synchronous-motor controls are described in detail. Safety cabinets for enclosing the controls are also listed.

PIPING

A. M. Byers Company, Pittsburgh, Pa.

"Wrought Iron for Underground Services" is a new standard-size 36-page catalog dealing with the corrosion of underground piping and with methods of overcoming it. Water and oil well piping and distribution systems, lawn sprinkler piping, gasoline lines and tanks, and electrical cable conduit are dealt with in their various phases. Booklet is profusely illustrated.

HEATING DEVICES

American Radiator & Standard Sanitary Corporation New York, N. Y.

A 12-page, 11 x 14 in. pamphlet, attractively illustrated in two colors, shows a number of the intricate steel, iron, magnesium, and brass castings being produced by the company for the armed forces of the nation. Also shown are air handling devices, heat exchangers, coolers, heaters, condensers, and other items used in the heating field.

WEEKLY CALENDAR

Frederick Post Company, Chicago, Ill.

A 52 sheet weekly calendar for 1943 is available upon request on a company letterhead. Each sheet shows in large black letters the dates and days of the week, easily read from any part of a large room. Overall size of the calendar is 15¾ in. by 24½ in.

TEMPERATURE CONTROL

Leeds & Northrup Company, Philadelphia, Pa.

Catalog N-33C, size 7¾ x 10½ in., 45 pages, illustrates and explains the operating principles of Micromax measuring instruments and Thermohm temperature detectors. Typical industrial applications and installation data are given.

V-BELT DRIVES

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

A new standard size 12-page bulletin B-6051-C gives simplified charts and tables for quick selection of V-belt drives. List prices, stock sizes, dimensions and construction details are included for all Texrope drives, and additional information is supplied for vari-pitch sheaves, drives, and speed changers.

ISOLATION

The B. F. Goodrich Company, Akron, Ohio

Engineering Work Sheet No. 7901 has just been issued as a supplement to the company's catalog section on vibration-insulators. In questionnaire form, this 4-page 8½ x 11 in. folder will, when filled out, furnish the technical data required for proper recommendation and installation of the items shown in the catalog.

CONTROLS

The Hotstream Heater Co., 8007 Grand Ave., Cleveland, O.

A new 16-page bulletin, "Selecting Controls for Fuel Conservation," gives suggestions for the selection of automatic controls and instruments for natural draft coal firing, automatic stoker firing, natural draft oil burning, forced draft hand firing and chain grate and spreader stokers for heat and power.

CONTROLS

Wheelco Instruments Co., Chicago, Ill.

Five new standard-size bulletins have just been issued. Bulletin G23-2, 12 pages, discusses operating principles of vapor-pressure and gas-filled thermometers, and gives selection and application information. Bulletins G503-2 and G603-2, 8 pages each, illustrate and describe recording and indicating temperature controllers, respectively. Bulletin G303-2, 2 pages, covers indicating thermometers; and G403-2, also 2 pages, deals with recording thermometers.

WELDING

Eutectic Welding Alloys, Inc., New York, N. Y.

A standard size, 36-page, illustrated catalog outlining the new castolin eutectic low temperature welding technique as used with oxy-acetylene gas torches and metallic arc, carbon, induction, resistance, and furnace welding.

WITH THE MANUFACTURERS

THE NATIONAL RADIATOR CO.

Johnstown, Pa., elected new officials and a director at the regular meeting of its board of directors January 14. Leo J. Larkin, who has been a member of the board since June, 1939, was elected secretary-treasurer. Mr. Larkin succeeds the late John T. Llewellyn, who died recently. L. Nathaniel Hunter, vice-president in charge of engineering and post-war planning, has been elected a director to serve on the board in place of the late C. L. Crouse. Henry J. Halliwell, formerly assistant comptroller, was elected to the post of comptroller.

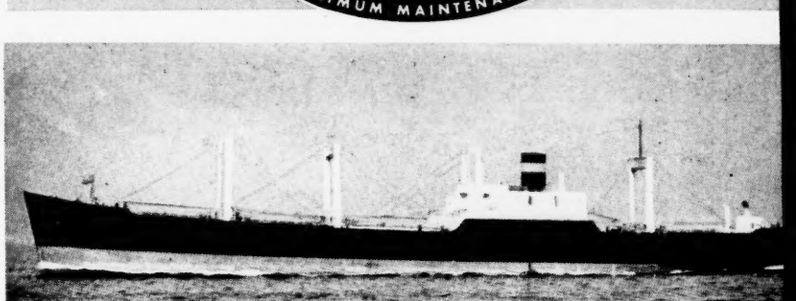
SALL MOUNTAIN CO.

176 West Adams Street, Chicago, Ill., manufacturers of non-metallic prefabricated Sal-Mo supply duct has appointed Air Devices, Inc., 17 East 42nd St., New York, as its exclusive sales representatives in the eastern seaboard states. Air Devices, Inc. will utilize its 22 territorial representatives in the sales of this product.

BARBER-COLMAN

MAXIMUM SERVICE Controls by BARBER-COLMAN COMPANY MINIMUM MAINTENANCE

GRILLES & REGISTERS
AIR DIFFUSERS
AUTOMATIC CONTROLS



Products For MARINE Service

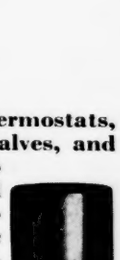
AIR TERMINALS

. . . WITH ADJUSTABLE DAMPERS

Designed especially for marine service, with built-in adjustable dampers which can be easily set to any desired position. Adjustment is accomplished by a ball-end rod with split wing nut bushing which provides a secure lock. In Recessed and Surface models for various requirements. Write for specifications.

AUTOMATIC CONTROLS

Wide variety of Thermostats, Motor-Operated Valves, and Power Units, also the Micro Control system, for accurate, dependable automatic temperature control. Proved rugged and reliable in service on various types of vessels. Applications specially engineered by experienced men for each type of installation.

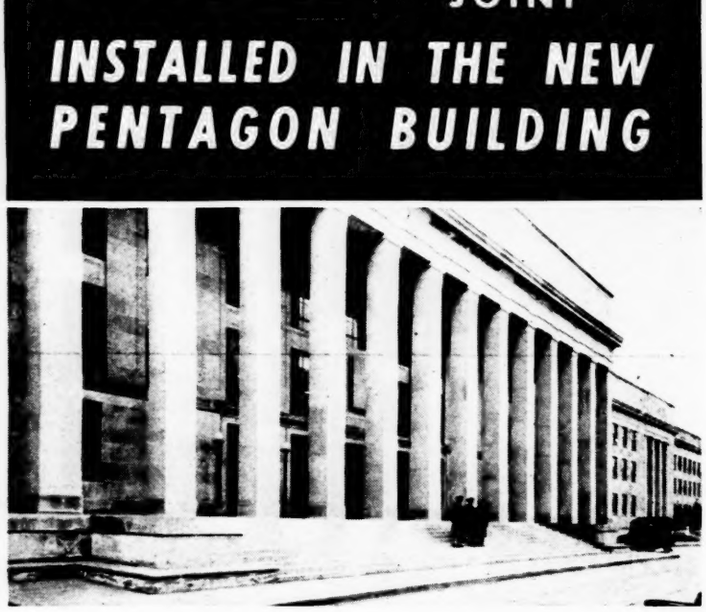


We have factory-trained engineers in all ship-building areas.

BARBER-COLMAN COMPANY 1224 ROCK STREET ROCKFORD, ILLINOIS

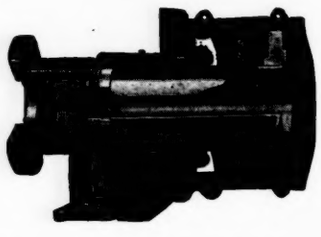
ADSCO PISTON-RING EXPANSION JOINT

INSTALLED IN THE NEW PENTAGON BUILDING



Charles S. Leopold, Mechanical Engineer
Baker Smith & Co., Mehring and Hanson, Heating Contractors

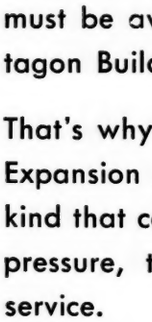
Fully guided internally and externally. Available in single or double joints for high pressure and high temperatures; flanged or beveled ends.



ONLY SLIP-TYPE JOINTS THAT MAY BE UNPACKED AND REPACKED UNDER PRESSURE

• Of all places where costly line shut downs must be avoided, Washington's big, busy Pentagon Building is a typical example.

That's why here you'll find ADSCO Piston-Ring Expansion Joints. Only slip-type joints of their kind that can be unpacked and repacked under pressure, thereby eliminating interruptions to service.



For steam, hot water, oil or gas lines, specify this modern expansion joint that is always on the job. Write for bulletin 35-15HV.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, NEW YORK
Makers of "UP-TO-DATE" Steam Line Equipment For Over 60 Years

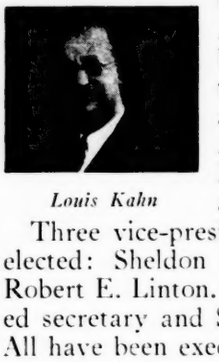
WESTINGHOUSE ELECTRIC & MFG. CO.

was awarded the Army and Navy E for excellence in the production of war materials, in ceremonies held January 21 at the East Springfield, Massachusetts, Works. Representing the Army in presentation of the coveted award was Brigadier General A. G. Gillespie, Commanding General of Watervliet Arsenal, N. Y., while Captain Gordon C. Hall, S. C., U. S. N. R., of the Boston Navy Yard acted for the Navy. W. O. Lippman, East Springfield Works manager and L. F. Benoit, labor representative, accepted the award for the company and its employees. Governor Saltonstall of Massachusetts and Mayor Putnam of Springfield extended greetings to the visitors and congratulations to the employees upon their record. The National Anthem was sung by John Charles Thomas, Metropolitan opera star and Lowell Thomas presided at the microphone. The company makes important interior equipment for tanks and planes and for combat and cargo vessels, and refrigerating apparatus for war industries.

PERSONALS AND PERSONNEL

LOUIS KAHN

for many years secretary-treasurer and executive head of Albert Kahn Associated Architects and Engineers, Inc., Detroit, has been elected president of the company, succeeding the late Albert Kahn. Mr. Kahn, who has been associated with the organization since 1909, is a registered architect and a member of the American Institute of Architects, Michigan Society of Architects, and Detroit Engineering Society.



Louis Kahn

Three vice-presidents of the company have been elected: Sheldon Maston, George H. Miehle and Robert E. Linton. George K. Scrymgeour was elected secretary and Saul Saulson is the new treasurer. All have been executives of the firm for many years and associate members since the present Corporation was formed.

DAVID W. HOPKINS

secretary and director of the R-S Products Corp., Wayne Junction, Philadelphia, for a number of years, has been elected vice president of that corporation. He will continue in charge of the company's Valve Division. Mr. Hopkins was graduated from the University of Pennsylvania as a mechanical engineer and later took post graduate work in aeronautical engineering at the Massachusetts Institute of Technology.

M. C. MORGAN

formerly field service engineer, has been appointed assistant Pittsburgh division sales manager of A. M. Byers Company. Mr. Morgan, who has been with Byers since 1923, will be associated in his new position with H. R. Rowland, division manager.

DR. ALBERT W. DAVISON

professor of chemical engineering and head of the industrial engineering curriculum at Rensselaer Polytechnic Institute, has joined Owens-Corning Fiberglas Corporation as scientific director of its research laboratories at Newark, Ohio. Dr. Davison has been head of the industrial engineering curriculum at Rensselaer since 1935. Under the direction of Games Slayter, vice president in charge of research, the Fiberglas laboratories employ some 400 engineers and technicians who, at the present time, are practically all engaged in activities designed to fit glass fiber materials to the developing needs of the war program.

OTTO Z. KLOPSCH

of the Wolverine Tube Division of the Calumet and Hecla Consolidated Copper Co., Detroit, has been appointed a member of the American Standards Association's Subcommittee on Minimum Requirements for Plumbing and Standardization of Plumbing Equipment.

P. D. BRIGGS

vice-president and general sales manager, and Harry J. Lagodzinski, sales representative in the Chicago branch office, were among twelve new members inducted into the 25-Year Club of the Ilg Electric Ventilating Co. at its annual banquet December 16.

INDUSTRIAL DEGREE DAYS DECEMBER, 1942

City	Number of Industrial Degree Days	
	55F Base	45F Base
Baltimore	618	309
Buffalo	923	613
Chicago	997	687
Cleveland	824	515
Detroit	913	603
Indianapolis	830	529
New York	727	415
Philadelphia	690	382
Pittsburgh	744	447
St. Louis	678	384

COMING EVENTS

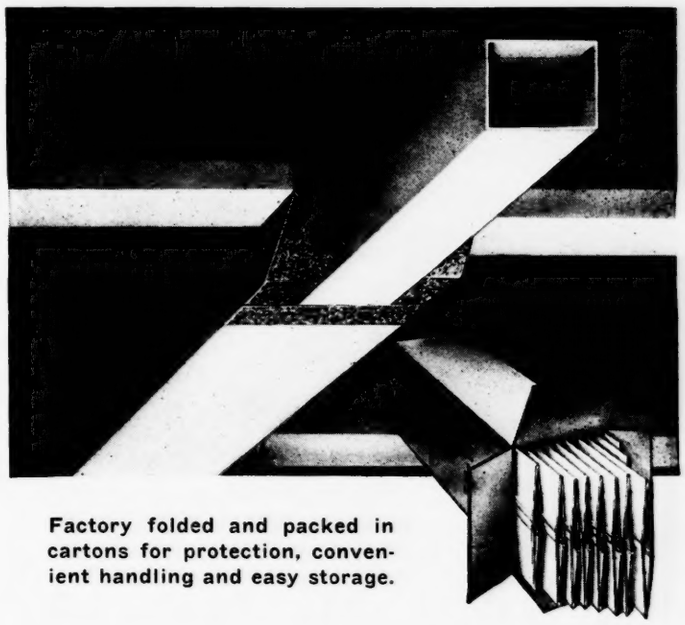
APRIL 9-10—Midwest Power Conference. To be held at the Palmer House, Chicago, Ill. For further information write to S. E. Winston, Director of Conference, Illinois Institute of Technology, 3300 Federal, Chicago, Ill.

H&V's PHOTOS

Pages 29-31—U. S. Maritime Commission.
Page 61—Ravenswood Photos, Chicago.

SAL-MO SUPPLY DUCT

Non-metallic Supply and Return Duct Material for Warm Air Heating, Ventilating and Air Conditioning Systems.



Factory folded and packed in cartons for protection, convenient handling and easy storage.

Approved and Listed By UNDERWRITERS' LABORATORIES, INC.

THIS non-metallic conduit saves metal in making supply and return duct lines for warm air heating, ventilating and air conditioning systems. It permits many installations that would otherwise be impossible because of the shortage in critical metals.

Tested and checked by independent laboratories, Sal-Mo Supply Duct has been shown to possess a wide margin of safety; it is Approved and Listed by Underwriters' Laboratories, Inc.

Factory fabricated and packaged in cartons, there is no waste space in shipping and storing. It is most economical to handle.

Sal-Mo Supply Duct is also furnished in flat sheets for fabrication of ducts or for insulation.

NO SHORTAGE—Available in any quantity, in a complete range of sizes for domestic and industrial requirements.

For Full Information Write

SALL MOUNTAIN COMPANY
176 W. Adams St., Dept B-3, CHICAGO, ILL.